Unlock the crystallographic and microstructural secrets of your samples.

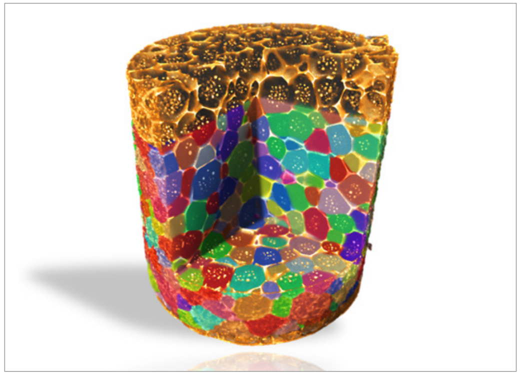
ZEISS Xradia CrystalCT

ZEISS

Seeing beyond

The world's first commercial implementation of diffraction contrast tomography on a microCT

ZEISS Research Microscopy Solutions and Xnovo Technology have partnered to deliver a revolutionary new laboratory diffraction contrast tomography (DCT) capability: ZEISS Xradia CrystalCT, the first commercial DCT system on a micro-computed tomography (microCT) platform. ZEISS Xradia CrystalCT is faster, offers higher throughput, larger volume imaging, and a wider array of sample geometries than any previous commercially available system. Traditional X-ray tomography opens the door to non-destructive 3D investigation of samples, delivering information related to porosity, defects, and other microstructural features. Augmenting the already powerful technique of computed tomography with the ability to reveal crystallographic grain microstructure transforms the way in which polycrystalline materials can be studied, leading to newer and deeper insights into your materials research. Taking this capability out of the synchrotron and bringing it to your high-productivity lab enables you to benefit from the latest X-ray imaging advancement to propel your research to a new dimension.

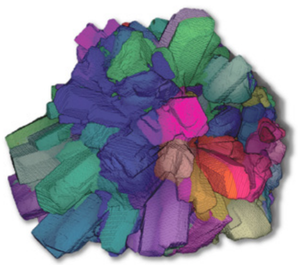


Aluminum copper alloy imaged in absorption and diffraction contrast tomography. Colors indicate grain orientation overlaid onto absorption data that discern the copper along grain boundaries.

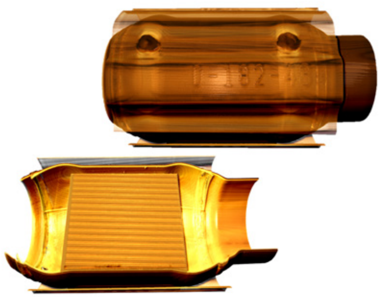
ZEISS Xradia CrystalCT enables standard and three unique modes of advanced diffraction scanning capability: helical phyllotaxis, helical phyllotaxis raster, and helical phyllotaxis HART (high aspect ratio tomography)

Diverse. Innovative. Accessible.

Diffraction Contrast Tomography (DCT) for an Expanded Range of Research Possibilities
With its large field of view flat panel detector, ZEISS Xradia CrystalCT is built to address a wide spectrum of imaging needs in research and industrial applications. Using 3D grain mapping, DCT on a microCT brings within the reach of technical and industrial research labs the ability to image single-phase polycrystalline materials, covering a wide range of metal, mineral, ceramic, semiconductor, and pharmaceutical samples in 3D. Non-destructive CT also enables *in situ* and 4D studies to understand practically the impact of varying conditions over time. Innovative DCT acquisition modes remove the limitations for larger sample sizes, providing you with the ability to research more sample types. Faster acquisition speeds enable you to run samples in a shorter time, increasing your productivity and profitability. Seamless large volume grain mapping enables scanning samples faster and with more accurate representation of data.



Removing the Limits on Contrast
X-ray tomography for 3D non-destructive imaging has been widely adopted and operated under two primary contrast mechanisms for quite some time: X-ray absorption and phase contrast. Both rely on differences in material properties within the sample. However, single-phase polycrystalline materials, e.g., steels, alloys, and ceramics, do not exhibit absorption contrast differences between neighboring grains, which is necessary to reveal the underlying grain microstructure. Synchrotron-based X-ray imaging methods such as DCT— which provides crystallographic information from the diffraction signals of single-phase polycrystalline samples —were the first to successfully demonstrate results in this class of materials almost two decades ago. Now, advancing non-destructive 3D X-ray imaging one step further, new 3D characterization methods and capabilities are available on laboratory-based DCT with ZEISS Xradia CrystalCT, the world's highest performing microCT platform.



Built on a Powerful MicroCT Platform
ZEISS leverages its powerful Xradia technology to deliver world-leading performance on a microCT. With a robust stage, flexible software-controlled source/sample/detector positioning, and a large array detector, you can obtain high quality, high resolution scans with best-in-class contrast on entire objects or devices to reveal interior details in their full 3D context. The ZEISS Xradia imaging system combines its proven hardware architecture with state-of-the-art stability and drift compensation features. It is because of the superior stability of this renowned platform, that CrystalCT consistently surpasses one's comprehension of what a microCT can achieve.

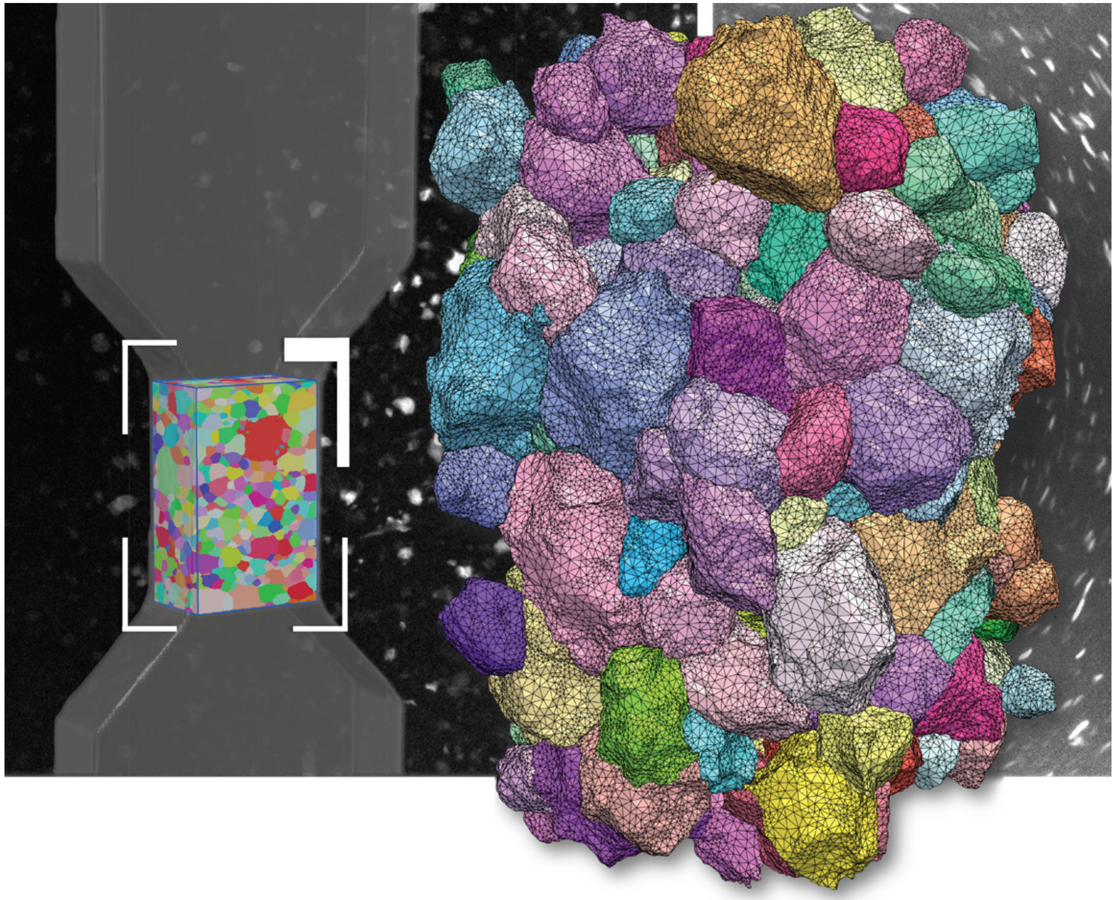
Your Insight into the Technology Behind It

A more advanced way of looking at crystallography

Virtual materials testing leads to rapid materials discovery, important for rapidly shifting industries like aerospace, automotive, energy, and construction. To enable this research, large volumes of real data are required to create high fidelity computational models, or data representivity. You can painstakingly image surface information and combine it with cross-sectioning to obtain volume data. But what if you could scan large representative volumes non-destructively to be used as a basis for your model?

2D optical and EM techniques provide surface-only measurements. When combined with destructive milling they do provide 3D information, but over limited smaller volumes with low sample representivity. Traditional DCT implementations at synchrotron and on early XRM solutions overcome these limitations.

ZEISS Xradia CrystalCT delivers cutting edge, radically different diffraction scanning technology, uniquely offering the ability to image large sample volumes in their native state while targeting realistic sample geometries that suit the common requirements of research and industrial labs.



Unlike other grain mapping technologies, DCT enables non-destructive 3D grain imaging. And now ZEISS Xradia CrystalCT allows you to map grain boundary surfaces over significantly larger volumes.

Your preserved sample enables additional and even correlative research: leverage *in situ* and 4D materials science in real-time or over-time to study the impact of temperature, mechanical loading, fracture mechanics, and other physical stimuli.

Your Insight into the Technology Behind It

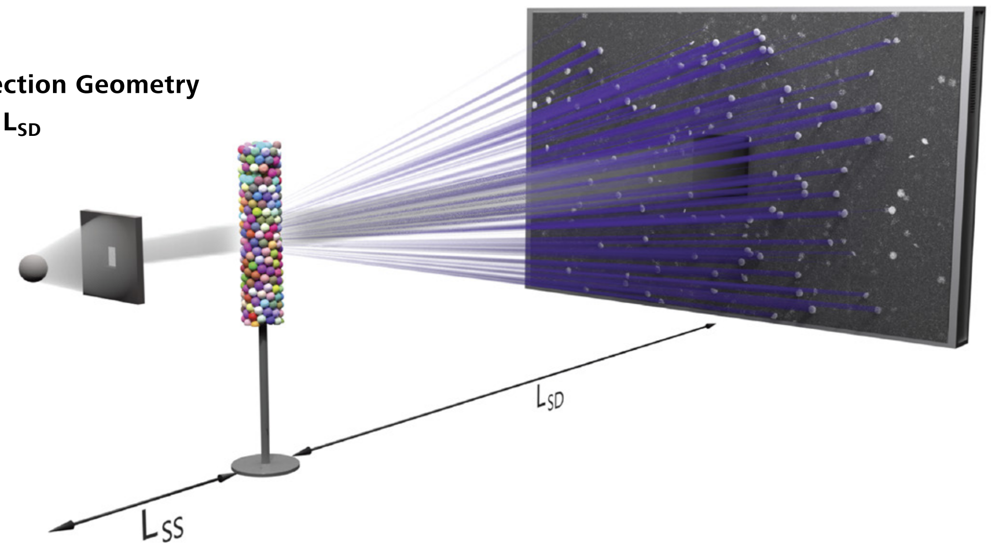
Diffraction Contrast Tomography Uniquely on a MicroCT

The purpose-built ZEISS Xradia CrystalCT leverages the robust design and high stability of the X-ray imaging architecture of ZEISS Xradia platforms, incorporating precisely designed aperture and beam stop assemblies. The divergent, polychromatic X-ray beam is constrained through the aperture to illuminate a region of interest (ROI) of the sample. The beamstop after the sample blocks transmitted X-rays on the detector to increase sensitivity towards the substantially weaker diffraction signals of polycrystalline samples.

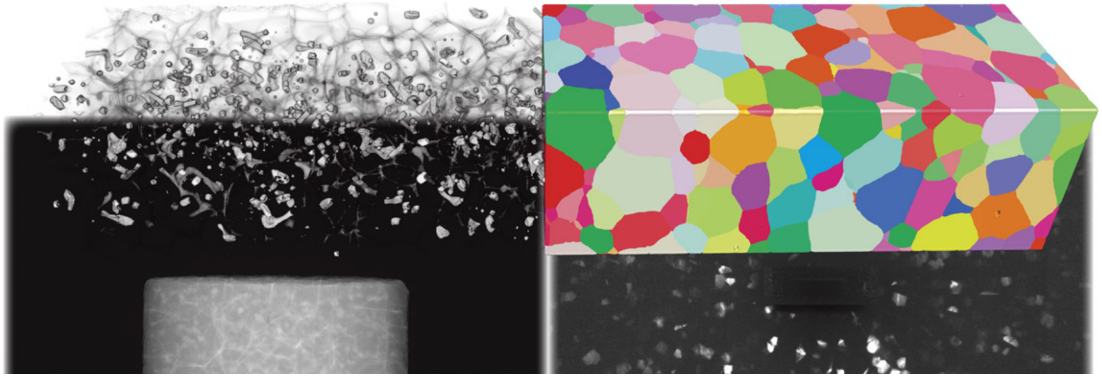
The single ZEISS Xradia CrystalCT platform delivers dual modalities: an absorption contrast tomography (ACT) scan to define the sample outline, and a diffraction contrast tomography (DCT) scan in which a specified number of diffraction contrast projections are collected as the sample rotates and translates.

Then the collected ACT and DCT data are imported into GrainMapper3D developed by Xnovo Technology for further processing and reconstruction. Information on grain morphology, crystallographic orientation, size, and centroid position is available from the reconstructed 3D grain map.

Projection Geometry
$L_{SS} < L_{SD}$



Schematic illustration of CrystalCT projection geometry. Exemplifying sample is sapphire spheres stacked in a tube.



Aluminum alloy with copper-decorated grain boundaries. Foreground: left portion of the sample displays the copper inclusions and grain boundary decorations from absorption contrast data; right portion shows the grain map with colors representing crystallographic orientations reconstructed from diffraction contrast data. Background presents a raw absorption projection (left) and the corresponding diffraction projection (right).

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Superior Sample Representivity from Advanced Diffraction Scan Modes

ZEISS Xradia CrystalCT advances materials characterization, modeling, and discovery through ground-breaking diffraction scanning modes that:

- Provide unprecedented sample representivity
- Enable scanning larger sample volumes
- Simplify sample prep, and handling of irregular/natural sample shapes
- Increase speed
- Address sample specificity

These advanced modes overcome some of the previous challenges of conventional DCT data collection, which assumes that the ROI in the sample is fully illuminated by the aperture field of view (FOV) for all rotational angles of the sample.

Inspired by nature's golden angle,advanced DCT scanning modes deliver helical phyllotaxis schema to manage a wide range of sample shapes and sizes.

Helical Phyllotaxis

Helical phyllotaxis rotation is used for long aspect ratio cylindrical samples.

Helical Phyllotaxis Raster

Helical phyllotaxis raster is used for samples that are typically wider than the field of view.

Helical Phyllotaxis HART

Phyllotaxis with high aspect ratio tomography, or HART, solves the problem of flat or plate-like sample imaging.

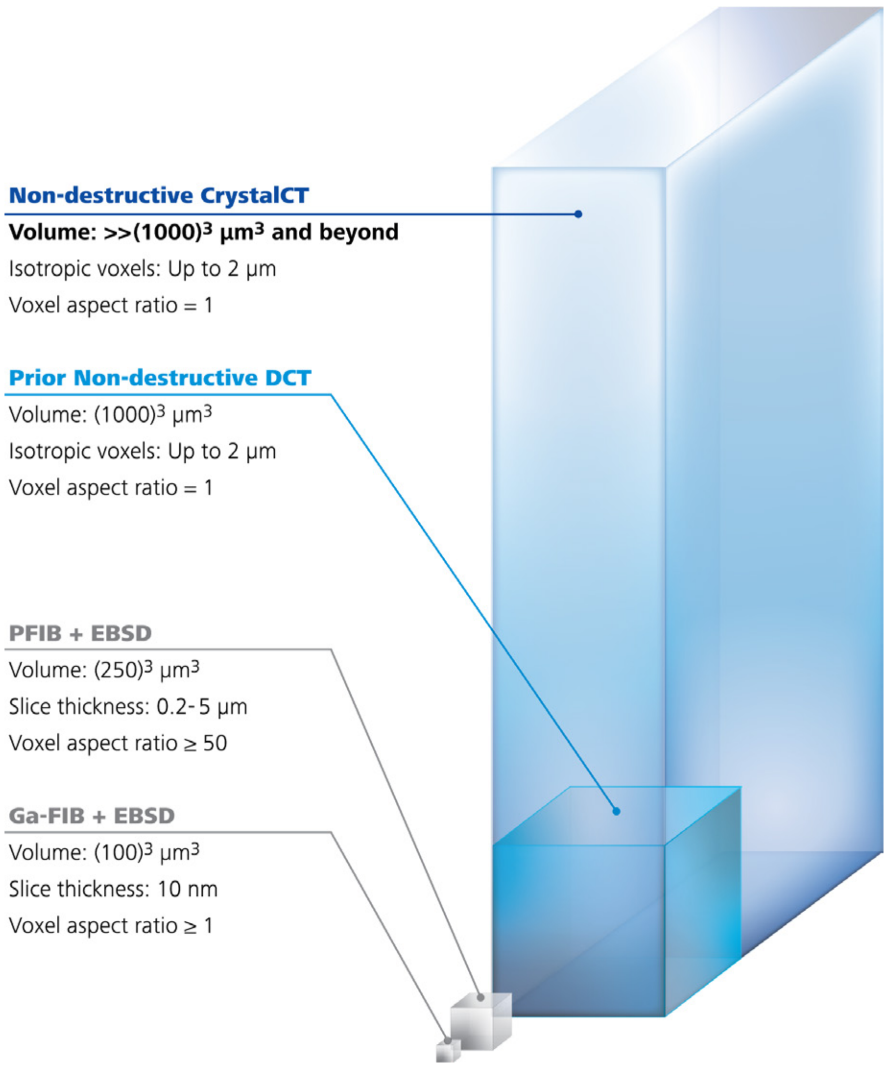

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Image Quality Based on the Proven Xradia Platform

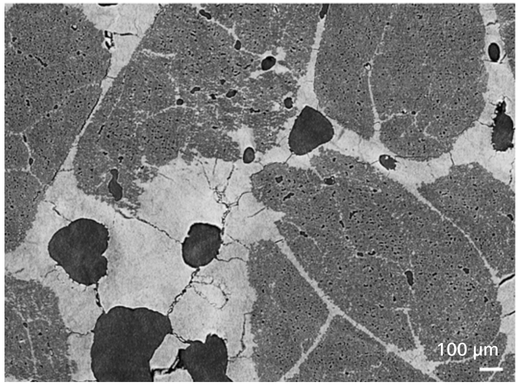
In addition to being a DCT platform, ZEISS Xradia CrystalCT is also a full micro-CT imaging system enabling high-resolution, submicron or large field-of-view, non-destructive 3D X-ray microcomputed tomography in research and industrial applications.

Excellent Data Quality

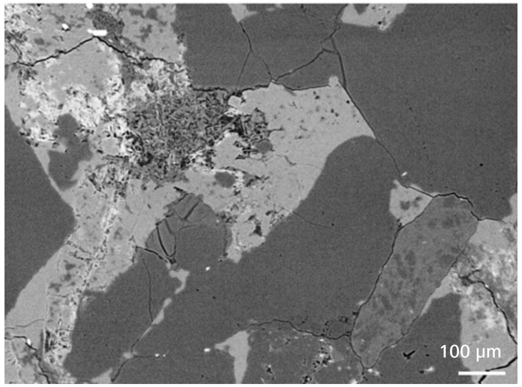
Excellent data quality relies on several factors including source characteristics, beam energy tuning, detector geometry and sensitivity, environmental control, motion and vibrational stability, careful system calibration, and reconstruction accuracy.

To address these challenges, ZEISS Xradia CrystalCT is built on the same platform as the proven Xradia Versa X-ray microscope series, inheriting the stabilization mechanisms and data quality advancements that helped Xradia Versa set the standard in high performance 3D X-ray imaging in the laboratory. Experience excellent contrast and image clarity, enabling easy differentiation of phases and features to support downstream segmentation and quantification of your data.

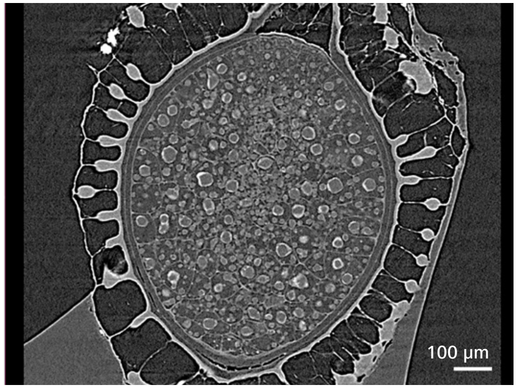
Further extend your field of view with integrated vertical stitching functionality. Maximize geometric magnification with small samples to identify and characterize micron-scale structures with high contrast and clarity. From sample mounting to scan preparation, acquisition, multi-GPU reconstruction, and image processing and analysis, experience an efficient high throughput workflow that gets you to results quickly.



Woven ceramic matrix composite sample imaged after mechanical testing. Bright regions are the ceramic matrix, medium gray regions are fiber bundles at a crossover point, and dark regions are voids.



Tight sand rock specimen showing the carbonate and quartz content along with intergranular crack networks.



Virtual cross-section of a Cyclanthus Bipartitus seed, showing intricate internal details.

Your Insight into the Technology Behind It

A Closer Look at Spatial Resolution

ZEISS Xradia microCT and X-ray microscopy systems are specified on true spatial resolution, the most meaningful measurement of your instrument's performance.

Spatial resolution refers to the minimum separation at which your imaging system can resolve a feature pair. You would typically measure it by imaging a standardized resolution target with progressively smaller line-space pairs. Spatial resolution accounts for critical characteristics such as X-ray source spot size, detector resolution, magnification geometry, and vibrational, electrical and thermal stability.

Other terms such as "voxel," "spot size," "detail detectability," and "nominal resolution" do not convey your system's full performance.

ZEISS Xradia CrystalCT specifies spatial resolution at short source-sample working distance indicative of results for a very small sample, as is practice in the industry. For larger working distances/samples, all CT and microCT systems relying on a projection-based architecture will have magnification that is strongly dependent on the working distance (in contrast to X-ray microscopy, where spatial resolution is not strongly dependent on working distance).

Therefore, to provide an indication of the operating space, ZEISS Xradia CrystalCT also specifies the achievable voxel size at different working distances.

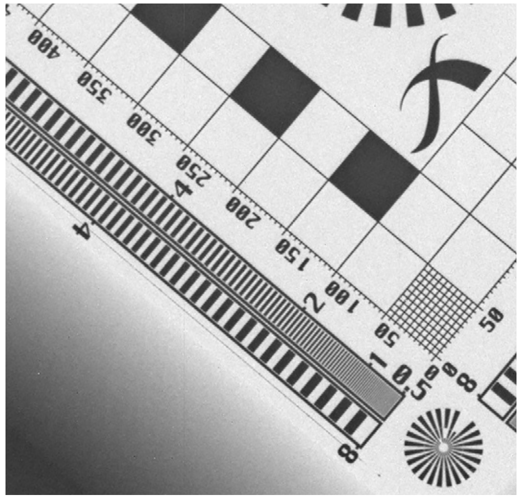
As the leader in X-ray imaging, ZEISS provides this transparency to true system performance.

Imaging Specifications	
Minimum Achievable Voxel [b]	0.5 µm
Spatial Resolution [a]	0.95 µm
Achievable Voxel at Working Distance [b,c]	0.5 µm / 0.5 mm
	0.8 µm / 2.5 mm
	2.5 µm / 12.5 mm
	4.0 µm / 25 mm
	12.1 µm / 100 mm

[a] Spatial resolution measured with ZEISS Xradia 2D resolution target.

[b] Voxel is a geometric term that contributes to but does not determine resolution and is provided here only for comparison. ZEISS specifies resolution via spatial resolution, the true overall measurement of instrument resolution.

[c] Working distance defined as clearance around axis of rotation. This value can be interpreted as the radius of the sample.

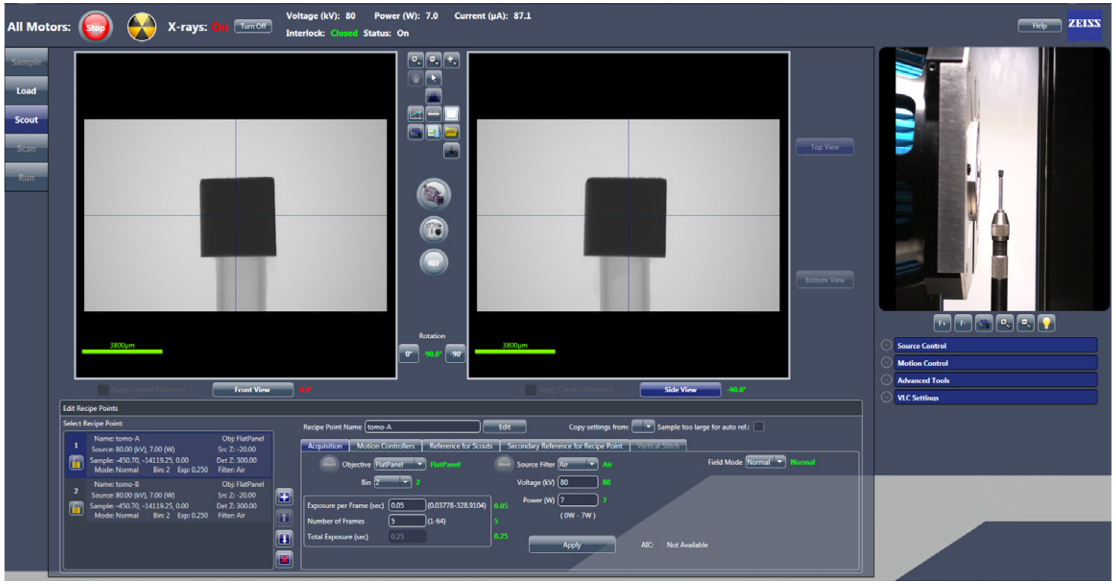


ZEISS Xradia resolution target, used to evaluate sub-micron spatial resolution. Minimum voxel size of 0.5 µm.

Your Insight into the Technology Behind It

Simple Control System to Create Efficient Workflows

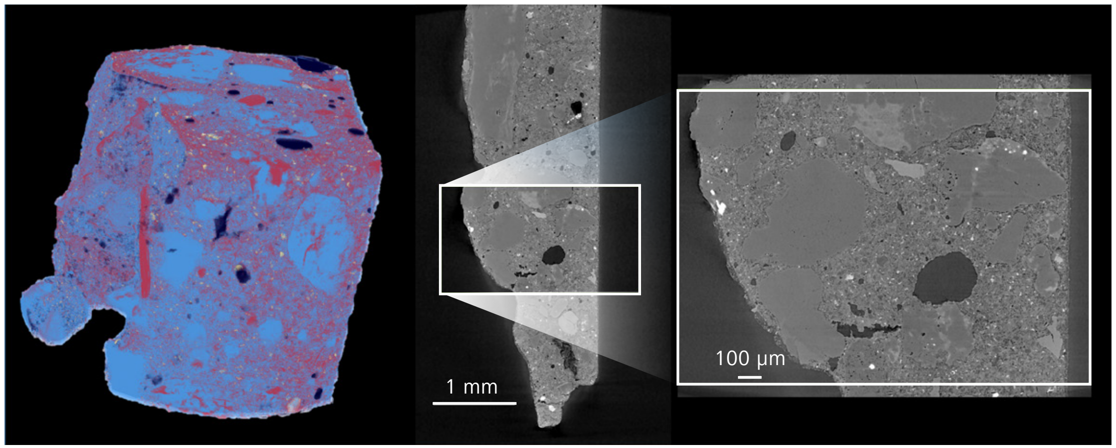
All of the features of ZEISS Xradia CrystalCT are seamlessly integrated within the Scout-and-Scan Control System, an efficient workflow environment that provides full control over the system hardware and allows you to easily position a region of interest, specify scanning parameters, and begin scans. The easy-to-use interface is ideal for a central lab-type setting where your users may have a wide variety of experience levels, enabling even novice users to begin collecting data quickly. The interface maintains the flexibility for which ZEISS Xradia systems are known, enabling you to set-up scans with ease and with recipe-based repeatability, especially useful for your *in situ* and 4D research or repetitive sample scanning.



Workflow-based Scout-and-Scan control system

Advantages

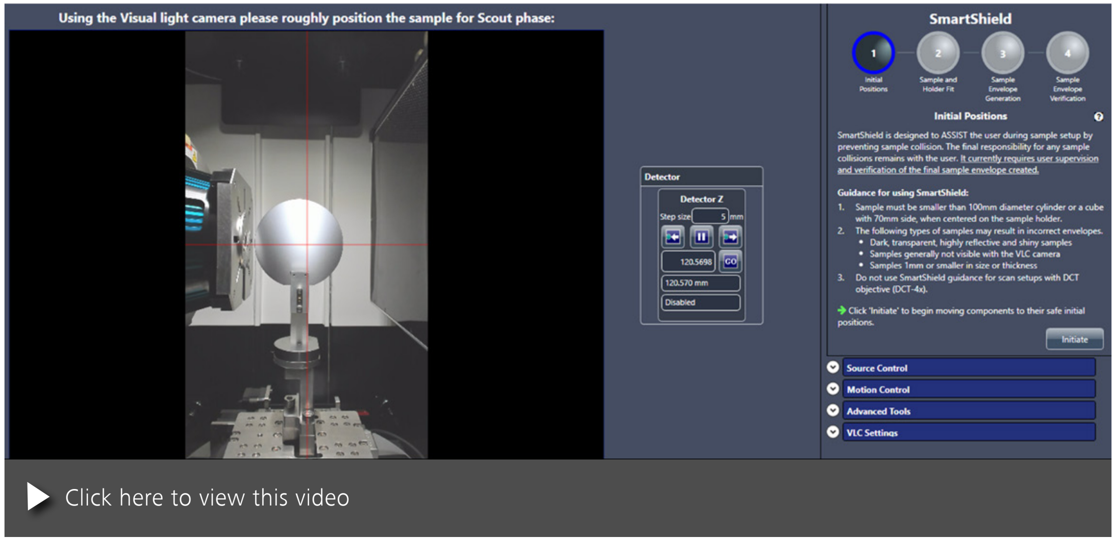
- Internal camera for sample viewing
- Smart positioning sample navigation stage to easily position your region of interest on the tomography rotation axis
- Recipe control (set, save, recall) to enable multiple scans with different parameters allowing batch mode
- Easy set-up to stitch multiple scans of large objects with vertical stitching
- Automated reconstruction
- Collision avoidance for system set-up, custom models, and disable feature for highest resolution scans
- Integrated *in situ* recipe control for Deben chambers



High resolution 3D imaging of a concrete sample: scout the sample and zoom to regions of interest for further analysis

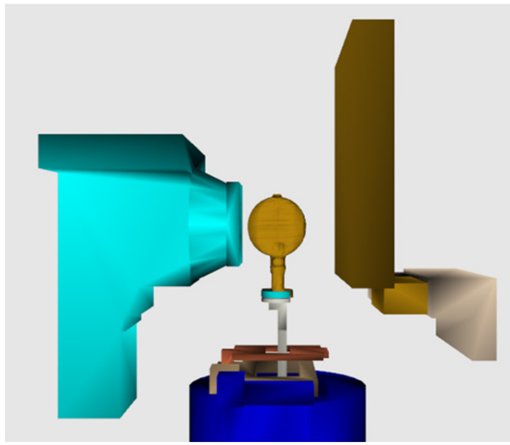
Your Insight into the Technology Behind It

ZEISS SmartShield – Protect Your Sample and Optimize Experiment Setup
ZEISS SmartShield is a simple solution that protects your sample and your microscope, working within the Scout-and-Scan control system. ZEISS SmartShield wraps a digital "envelope" around your sample with an easy click of a button. This automated solution allows you to confidently bring your sample even closer to the source and detector. With ZEISS SmartShield, new and advanced users alike can experience an elegant sample setup workflow and efficient navigation of the ZEISS Xradia CrystalCT system.



Watch this video and gain insights into the workflow guided by SmartShield.

What SmartShield Offers
- Fully integrated rapid envelope creation within Scout-and-Scan
- 3D awareness for sample and instrument safety
- Enhanced operator efficiency during setup



Digital safety envelope of the sample created by ZEISS SmartShield

Your Insight into the Technology Behind It

Advanced Reconstruction Toolbox

The Advanced Reconstruction Toolbox is an innovative platform on which you can continuously access state-of-the-art reconstruction technologies from ZEISS to enrich your research and increase the return on investment of your ZEISS Xradia 3D XRM.

These unique offerings from ZEISS leverage deep understanding of both X-ray physics and customer applications to solve some of the hardest imaging challenges in new and innovative ways. These optional modules are workstation-based solutions that provide easy access and usability.

	FDK Standard Analytical Reconstruction	OptiRecon Iterative Reconstruction	DeepRecon Pro AI (Deep-Learning) based Reconstruction
Throughput	1×	up to 4×	up to 10×
Image Quality*	Standard	Better	Best
Ease-of-Use	Minimal	Requires parameter optimization	One-click setup
Applicability	Repetitive and non-repetitive workflows		

* Image quality refers to the contrast-to-noise ratio and the relative performance of reconstruction technologies is shown.

ZEISS DeepRecon

The first commercially available deep learning reconstruction technology enables you to increase throughput by up to 10×. Alternatively, keep the same number of projections and enhance the image quality further. DeepRecon uniquely harvests the hidden opportunities in big data generated by your XRM and provides significant AI-driven speed or image quality improvement.

ZEISS offers DeepRecon technology in 2 forms – 1) DeepRecon Pro, and 2) DeepRecon Custom – both leveraging AI to provide unprecedented image quality with unparalleled speed.

ZEISS DeepRecon Pro is an innovative AI-based technology bringing superior throughput and image quality benefits across a wide range of applications. DeepRecon Pro is applicable to both unique samples as well as semi-repetitive and repetitive workflows. Customers can now self-train new machine learning network models on-site with an extremely easy-to-use interface. The one-click workflow of DeepRecon Pro eliminates the need for a machine learning expert and can be seamlessly operated by even a novice user. ZEISS DeepRecon Custom is targeted specifically for repetitive workflow applications to further boost XRM performance beyond DeepRecon Pro. Customers can closely collaborate with ZEISS to develop custom-created network models that precisely fits their repetitive application needs.

ZEISS OptiRecon

A fast and efficient algorithm-based technology that delivers iterative reconstruction from your desktop, allowing you to achieve up to 4× faster scan times or enhanced image quality with equivalent throughput.

OptiRecon is an economical solution offering superior interior tomography or throughput on a broad class of samples.

ZEISS PhaseEvolve

ZEISS PhaseEvolve is a post-processing reconstruction algorithm that enhances the image contrast by revealing material contrast uniquely inherent to X-ray microscopy, which can often be obscured by phase effects in low-medium density samples or high resolution datasets. Perform more accurate quantitative analysis with improved contrast and segmentation of your results.

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ZEISS DeepRecon Pro – How It Works in Materials Science: Concrete

Standard Reconstruction (FDK) | **Standard Reconstruction (FDK)** | **DeepRecon Pro**

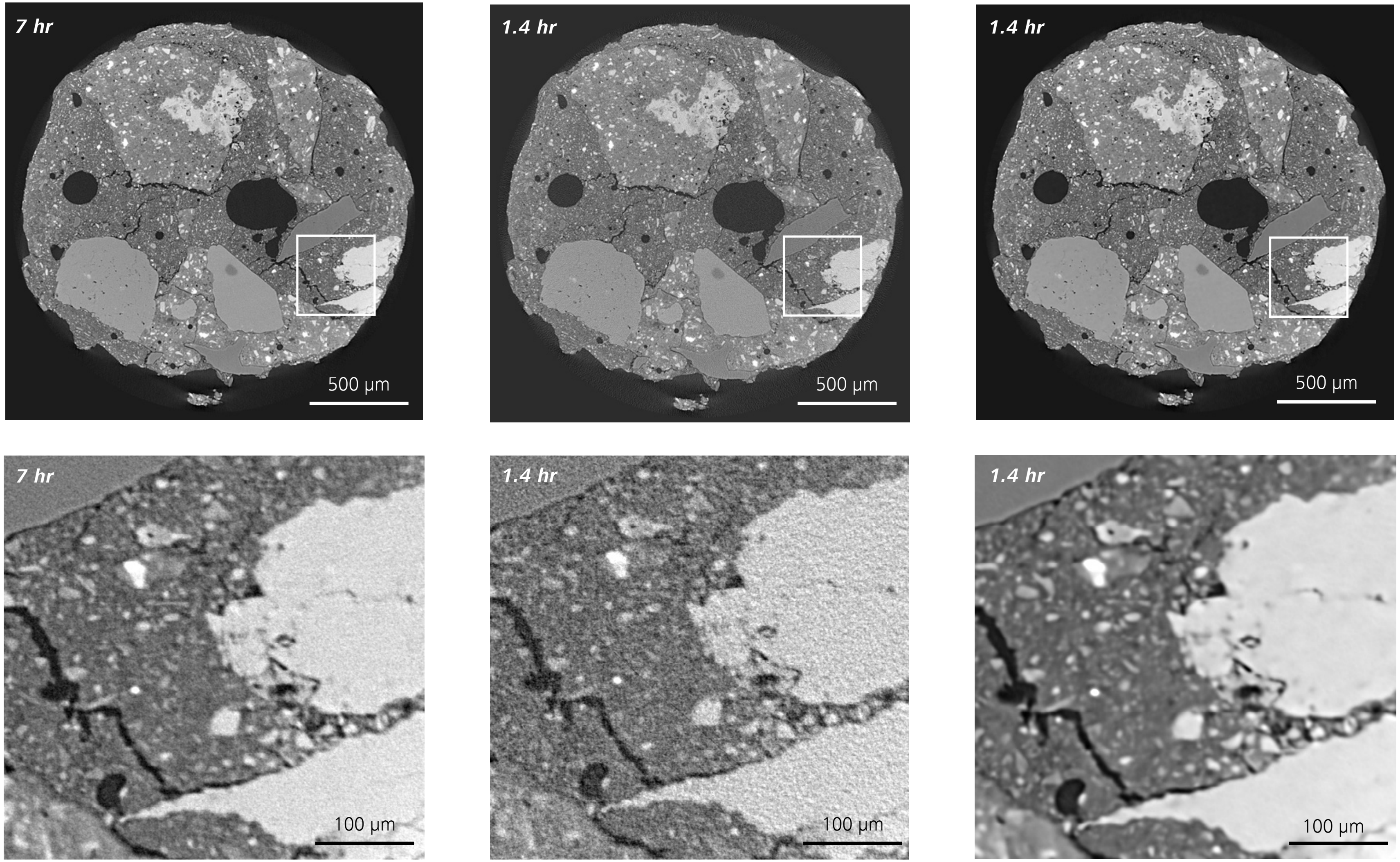

Image concrete samples 5x faster with DeepRecon Pro while retaining the image quality needed to quantify phase distributions and the extent of crack networks.

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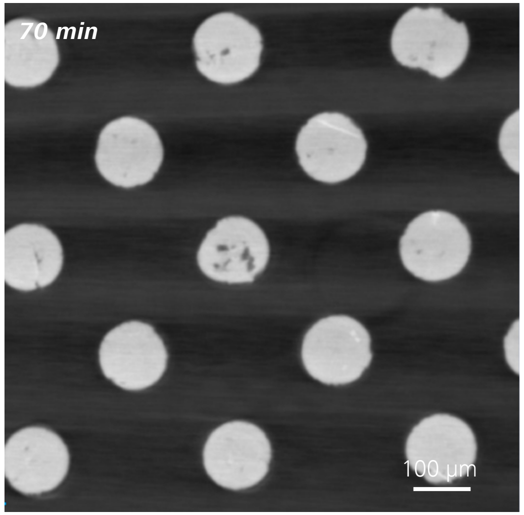
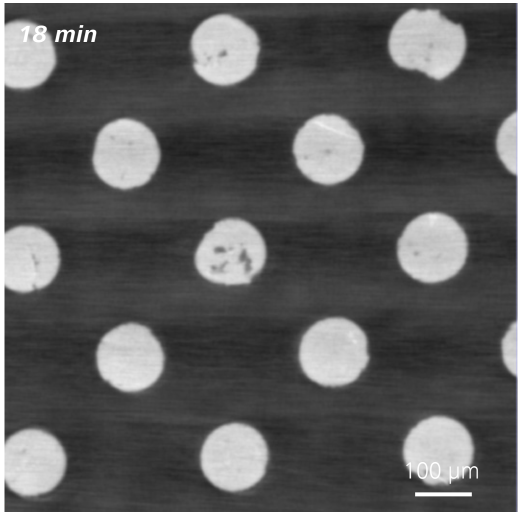
ZEISS DeepRecon Pro – How It Works in Electronics: Printed Circuit Boards (PCB)

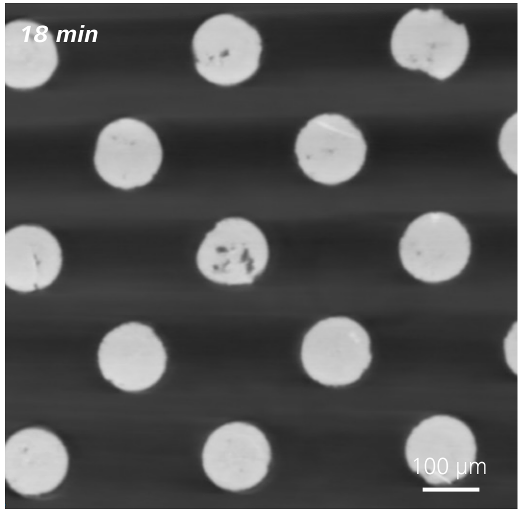
Standard Reconstruction (FDK)



Standard Reconstruction (FDK)



DeepRecon Pro



Perform failure analysis tasks in electronics up to 4x faster with DeepRecon Pro while still retaining the image quality needed to observe fine cracks in detail.

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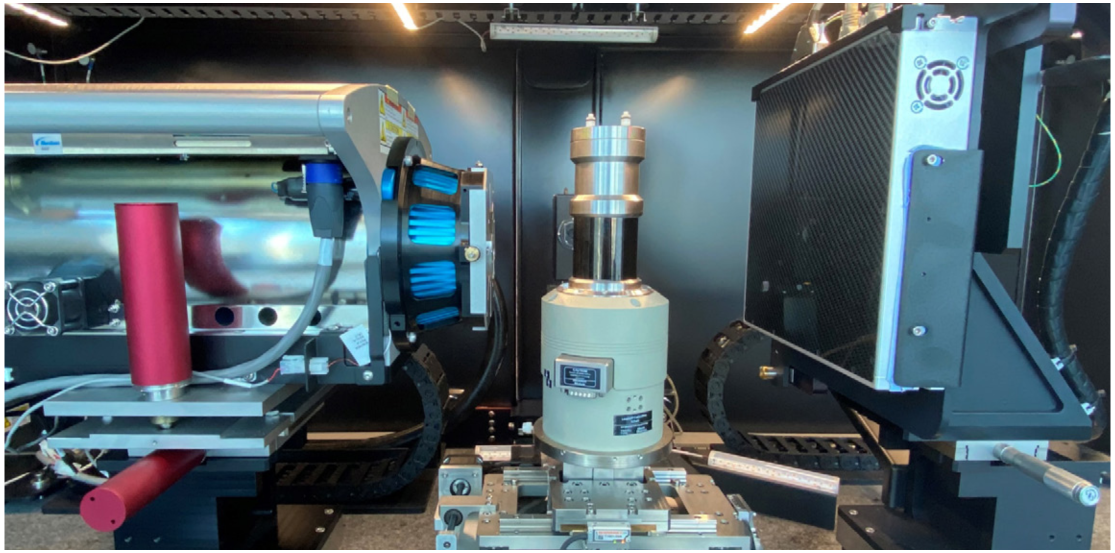
Add the ZEISS *In Situ* Interface Kit to Advance Discovery with 4D Imaging

Moving beyond the three dimensions of space, leverage the non-destructive nature of X-ray investigation to extend your studies into the dimension of time with 4D experiments. ZEISS Xradia CrystalCT can accommodate a variety of *in situ* rigs, from high pressure flow cells to tension, compression and thermal stages, to user-customized designs. You can add the optional *In Situ* Interface Kit to your ZEISS Xradia CrystalCT, which includes a mechanical integration kit, a robust cabling guide and other facilities (feed-throughs) along with recipe-based software that simplifies your control from within the Scout-and-Scan user interface. When your needs require pushing the resolution limits of your *in situ* experiments, convert your ZEISS Xradia CrystalCT to an Xradia 620 Versa X-ray microscope to leverage Resolution at a Distance (RaaD) technology for the maximum performance tomographic imaging of samples within *in situ* chambers or rigs.



Making the industry's best in situ *solution even better:* in situ *kit tracking with Deben thermomechanical stage*

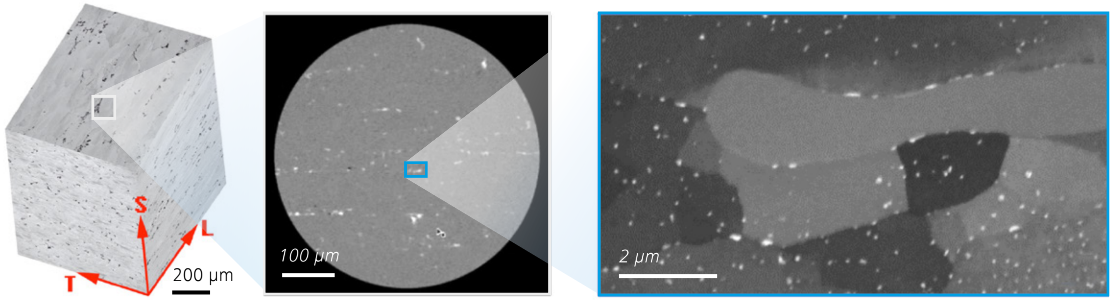
4D grain map of an Armco iron sample imaged at various annealing steps.
t0: initial state; t1: after annealing at 880 °C for 8 hrs; t2: after annealing at 880 °C for 16 hrs.
By imaging the sample at three temporal states, the abnormal grain growth of the top, pink-colored grain is captured.
Courtesy of Prof. Burton R. Patterson, University of Florida, United States.

Expand Your Possibilities

Correlative Microscopy

Drive correlative workflows starting with non-destructive X-ray imaging to seamlessly connect 3D X-ray, optical, and SEM analyses.

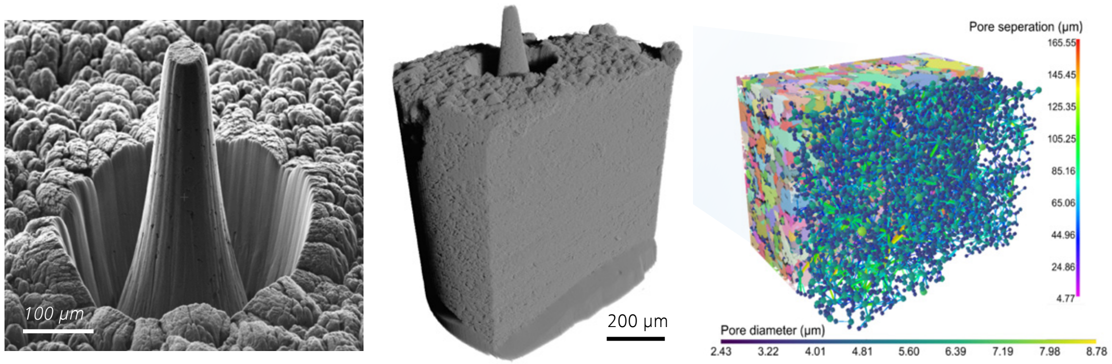
- Non-destructively scan your sample with ZEISS Xradia CrystalCT
- Drive your FIB-SEM analysis to the particular region of interest (ROI) guided by 3D tomography data
- Rapidly access deeply buried ROI with femto-second laser milling
- Carry out TEM or atom probe sample preparation of deeply buried structures of interest
- Conduct FIB-SEM tomography with industry-leading 3D resolution



Multiscale analysis of an aluminum 7075 alloy. ZEISS Xradia Versa scan of the sample (left). XRM interior tomography of a 0.75 mm field of view with 750 nm voxel size (center). FIB-SEM tomography slice showing a silicon inclusion (right). In collaboration with S. Singh and N. Chawla, Arizona State University.

Prepare Site-specific Samples for Your High-resolution MicroCT Scans with ZEISS Crossbeam Laser

- Rapidly prepare site-specific small diameter pillars for microCT analysis on extremely dense samples with ablation rates of up to 15 mio. µm³/s (silicon)
- Reduce sample damage and heat affected zones to a minimum thanks to ultrashort femtosecond laser pulses
- Enjoy site-specific laser preparation with down to 2 µm targeting accuracy



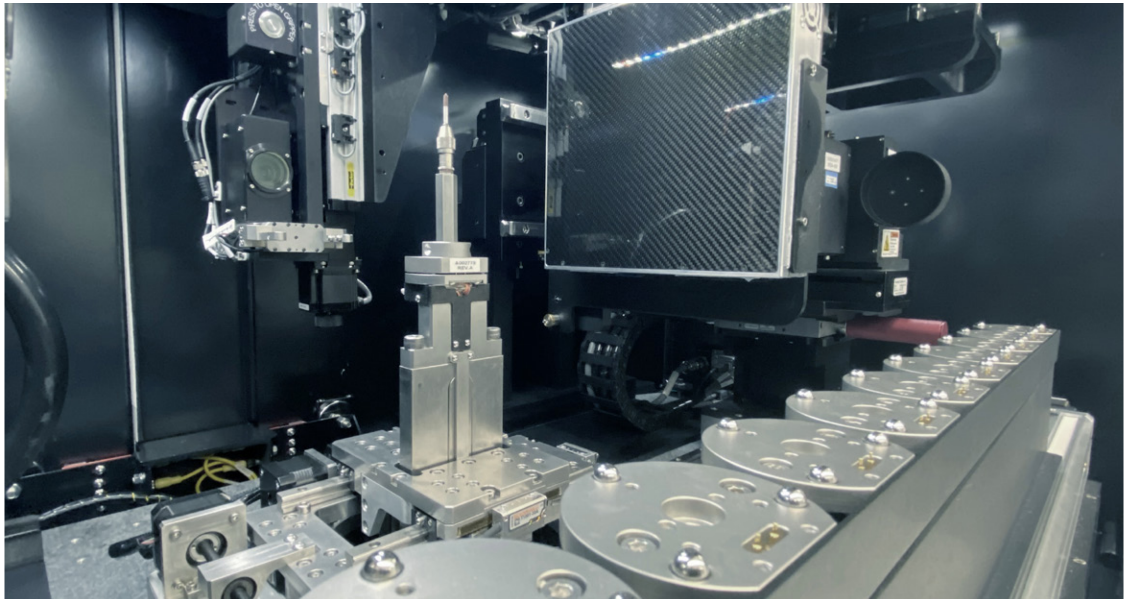
Pillar preparation of nuclear graphite with ZEISS Crossbeam laser (left); ZEISS Xradia Versa overview scan of the complete sample (center); 3D reconstructed and segmented data obtained with ZEISS Xradia Ultra XRM showing pore diameter and distances between pores (right).

Expand Your Possibilities

Autoloader to Increase Your Sample Handling Efficiency

Maximize your instrument's utilization by minimizing user intervention with the optional ZEISS Autoloader, available for all ZEISS Xradia Versa and CT systems. Reduce the frequency of user interaction and increase productivity by enabling multiple jobs to run. Load up to 14 sample stations, which can support up to 70 samples, queue, and allow to run all day, or off-shift.

Autoloader provides you with the flexibility to re-order, cancel, or stop the queue to insert a high priority sample at any time. An e-mail/text notification feature in the Scout-and-Scan user interface provides timely updates on queue progress. Autoloader also enables a workflow solution for high volume repetitive scanning of like samples.



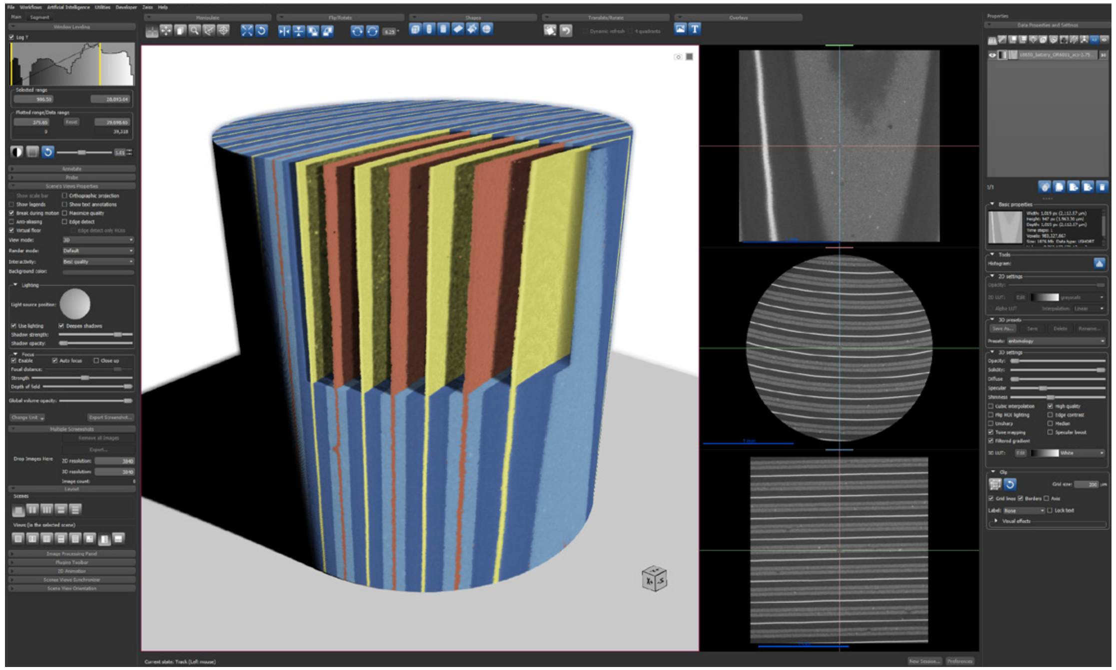
Autoloader option enables you to program up to 14 samples at a time to run sequentially.

Expand Your Possibilities

Dragonfly Pro: Your Visual Pathway to Quantitative Answers

Dragonfly Pro is advanced 3D visualization and analysis software from Object Research Systems (ORS), and offered exclusively by ZEISS for processing SEM, FIB-SEM, and X-ray data. Using advanced visualization techniques and state-of-the-art volume rendering, Dragonfly Pro enables high definition exploration into the details and properties of your datasets. You can register multiple datasets within the same workspace, and easily manipulate your 2D and 3D data with an extensive image processing feature set.

Grain maps produced from Xnovo GrainMapper3D, as part of the LabDCT module for Versa or CrystalCT system, can be imported into Dragonfly Pro and visualized with other types of datasets such as absorption contrast tomography.



Engineered to Support the Needs of Microscopists

- A common workspace for integrating multi-scale correlative microscopy, spanning cm to nm
- Simple, intuitive user interface
- Customizable with Python

Process Data Acquired by ZEISS Microscopes

- Read and write various formats including .txm and .czi
- Auto-process and apply macros to automate workflow
- Offered exclusively through ZEISS

Expand the Software through Optional Modules

- Deep Learning for advanced segmentation
- Bone Analysis for accurate specialized metrics

Full-featured 3D Visualization and Data Analysis Platform

- Find quantitative answers with powerful yet intuitive segmentation and analytical tools
- Create compelling visual media

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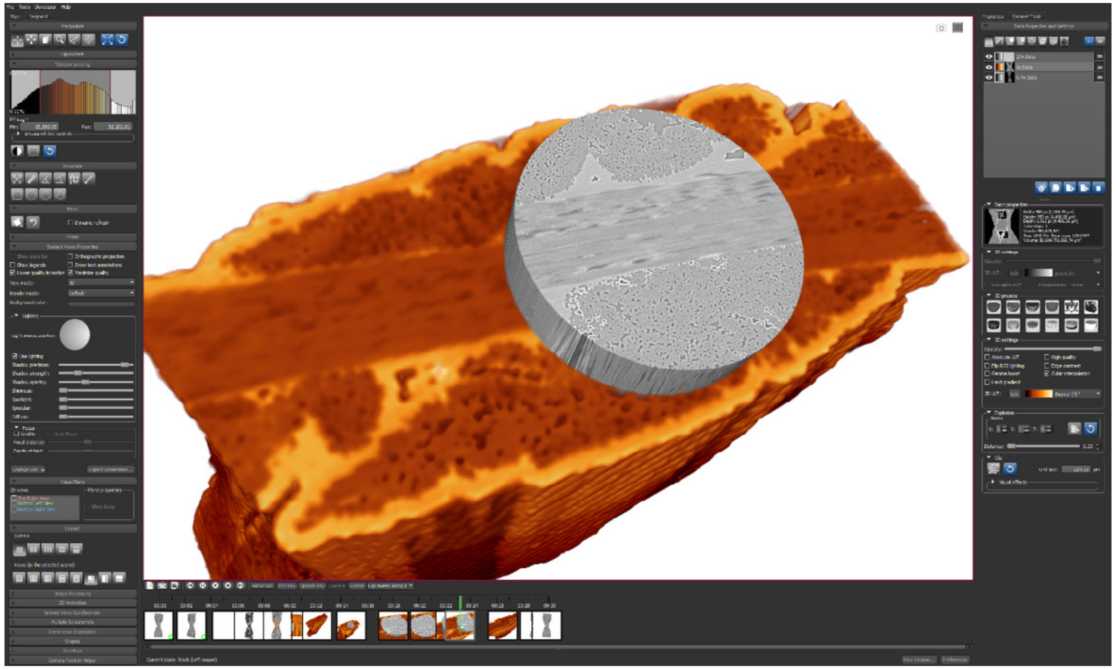
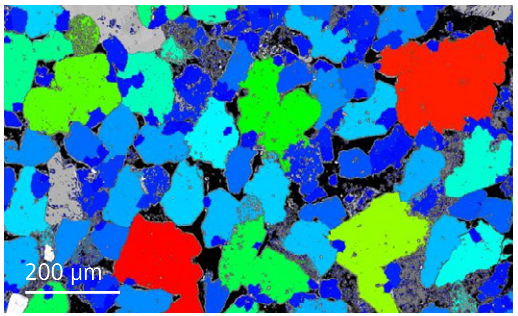
Dragonfly Pro from ORS is a configurable software package. You can tailor the tools that are optimal to your workflow, and choose from plug-ins that allow you to control registration, map differences, and customize appearance. Dragonfly Pro also supports regular and unstructured surface meshes, and contains advanced editing tools to create regions of interest from a mesh and vice-versa. With the Plug-In Development Kit (PDK), you can leverage the Dragonfly Pro core technology to quickly build specialized workflows.



Tailor the tools that are optimal to your workflow: choose plug-ins that allow you to control registration, map differences, and customize appearance. Ceramic matrix composite, imaged on a ZEISS Xradia Versa microscope. Sample courtesy of Dr. David Marshall, University of Colorado.



Compute morphometric properties to visualize quantitative answers: Sandstone imaged by SEM showing volume distribution of grains in sandstone. Courtesy of Imperial College London

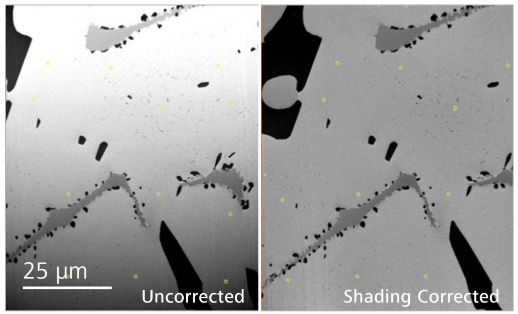


Image filtering: Correct shading, denoise. Nickel carbide alloy imaged by Crossbeam FIB-SEM. Dataset courtesy of P. Bala, AGH University.

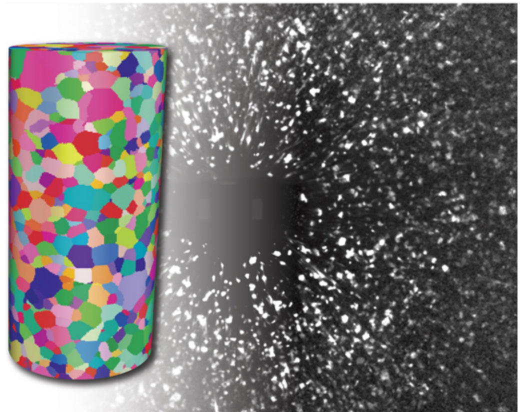
Precisely Tailored to Your Applications

	Task	ZEISS Xradia CrystalCT offers
Materials Research	Characterize crystallographic grain orientation and microstructural features including pores, cracks, voids, and other subsurface defects Analyze heterogeneity in composites and other multiphase functional materials Visualize and quantify microstructural change with 4D imaging Use non-destructive 3D datasets to identify regions of interest for further investigation Characterize particle size, shape, orientation and dispersion in 3D space within the pharmaceutical application space.	Complementary information from high resolution absorption contrast tomography and non-destructive 3D grain mapping delivering size, shape, orientation and grain boundary information Non-destructive insights into interior microstructures and overlaid grain maps not visible by surface imaging methods such as optical or scanning electron microscopy Ability to segment and analyze data to obtain quantitative, 3D descriptions of structures and particles 4D imaging through *ex situ* or *in situ* experiments to see how materials evolve, e.g., through mechanical load or corrosion
Raw Materials	Characterize crystallographic orientation and texture of minerals, metals, and alloys Research the effect of processing variables to improve materials performance Characterize heterogeneity at core plug scale and quantify pore structures Perform failure analysis – identify the cause of failure and identify defects/inclusions for root cause identification Advance mining processes: analyze tailings to maximize mining efforts; conduct thermodynamic leaching studies; perform QA/QC of mining products such as iron ore pellets	Understand grain size and phase evolution in 3D for insight into alloy performance and its dependence on thermal and mechanical processes Export real 3D structures for physics simulations: predict materials properties (mechanical, thermal, etc.) or digital rock simulations using non-destructive 3D tomography data Imaging, characterization, and modeling of rock cores (up to 4”) with high throughput High contrast 3D imaging for *in situ* flow studies or 3D mineralogy
Manufacturing and Assembly	Evaluate internal surface roughness of additive manufactured parts Image components and devices for inspection or failure analysis Optimize process development for electronics, automotive, and medical device industries	Accommodate a range of sample sizes including large objects in their full 3D context, complementing with 3D grain maps in specific applications Perform crystallography-based print quality assessment in 3D printed metal parts High throughput scanning of intact devices with fast time to results Complement or replace physical cross sectioning and eliminate the need to sacrifice your sample
Life Sciences	Perform virtual histology on a range of sample sizes from clusters of cells to whole animals Expand your views in developmental biology with high resolution, high contrast images of cellular structure Image large intact samples such as brains, large bones, and whole animals Explore 3D organization of plants, from seeds, root networks in soil to stem and leaf structure Analyze 3D structure of biomaterials and implants	Image either stained or unstained hard and soft tissues and biological micro-structure with high contrast Quick and nondestructive verification of sample staining and location of features for subsequent imaging using 3D electron microscopy

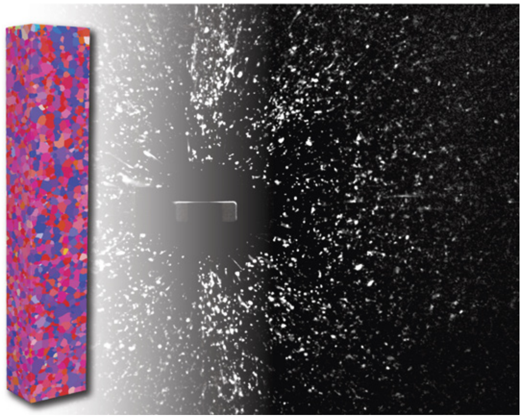
ZEISS Xradia CrystalCT at Work

3D grain map of an Al-4wt.%Cu sample with dimension of (diameter) 1.1 mm and (height) 5.1 mm. Sample scanned using helical phyllotaxis scheme.

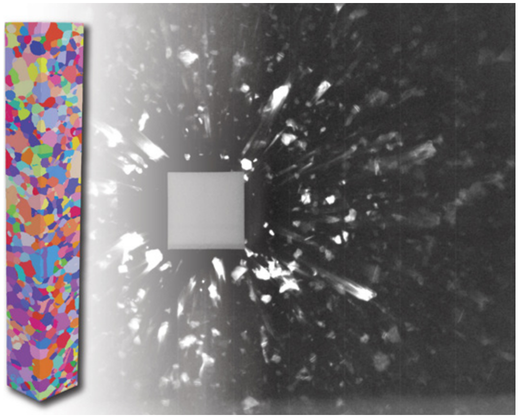
3D grain map of a ß-Ti sample with dimension of (side length)1.0 mm and (height) 3.2 mm. Sample scanned using helical phyllotaxis scheme.



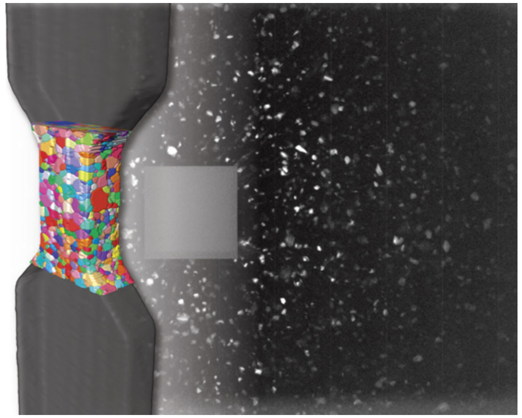
3D grain map of an armco iron sample with dimension of (diameter) 1.0 mm and (height) 3 mm. Sample scanned using helical phyllotaxis raster scheme. Sample courtesy of Prof. Burton R. Patterson, University of Florida, USA.



3D grain map of a low carbon steel sample with dimension of (side length) 0.4 mm and (height) 2.0 mm. Sample scanned using helical phyllotaxis scheme. Sample courtesy of Prof. Masao Kimura, KEK, Japan.

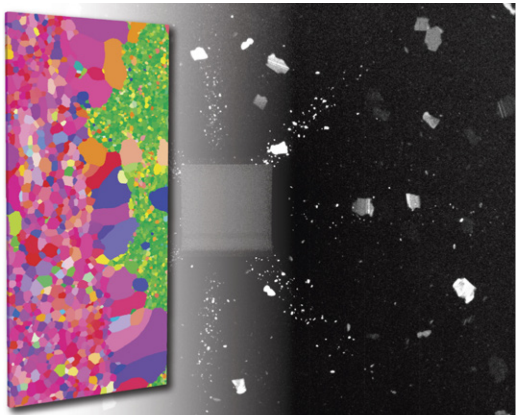


3D grain map of an austenitic stainless-steel sample with dimension of (side length) 0.66mm and (height) 4.4 mm. Sample scanned using helical phyllotaxis raster scheme. Sample courtesy of Prof. Grethe Wither, Technical University of Denmark.

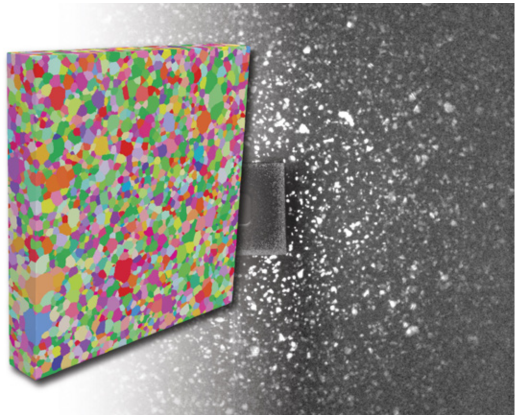


3D grain map of an Al-4wt%Cu sample with gauge section dimension of (length) 1.25 mm, (width) 1.0 mm and (thickness) 0.5 mm. Sample scanned using helical phyllotaxis HART. Sample courtesy of Prof. Masakazu Kobayashi, Toyohashi University of Technology, Japan.

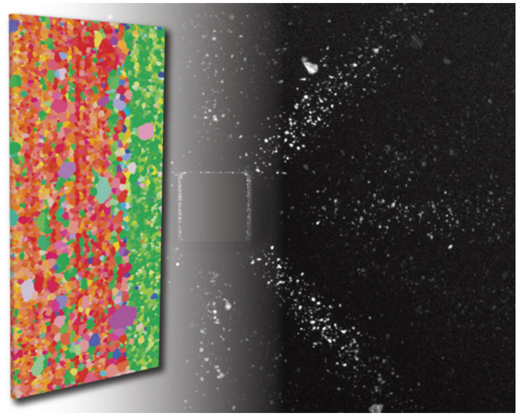
ZEISS Xradia CrystalCT at Work



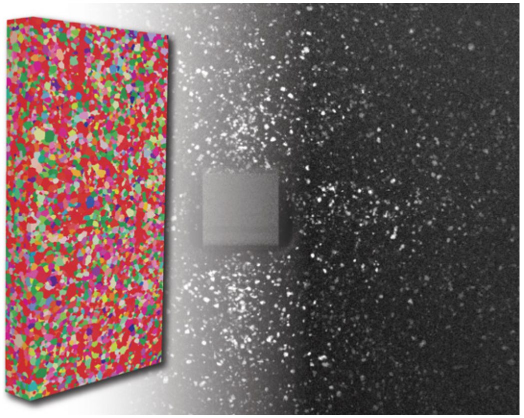
3D grain map of an ultra thin oriented electrical steel sample with dimension of (RD) 4 mm, (TD) 2 mm and (ND) 0.08 mm. Sample scanned using helical phyllotaxis HART scheme. Sample courtesy of Dr. Li Meng, China Iron and Steel Research Institute.



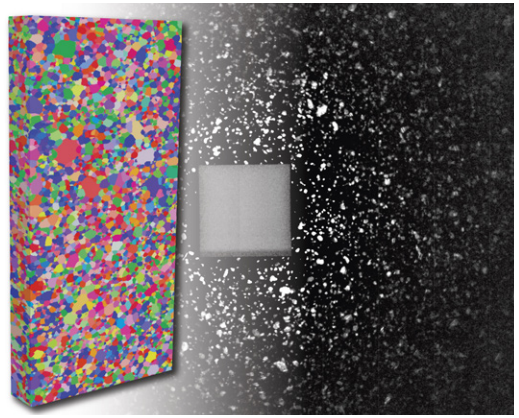
3D grain map of a 3% Si non-oriented electrical steel sample with dimension of (RD) 3 mm, (TD) 3 mm and (ND) 0.5 mm. Sample scanned using helical phyllotaxis HART. Sample courtesy of Dr. Ivan Petryshynets, Slovak Academy of Science, Slovakia.



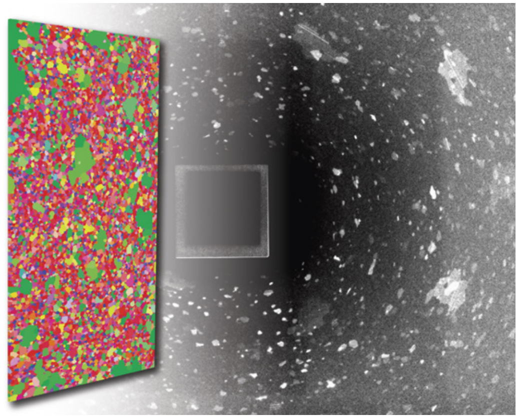
3D grain map of an ultra thin oriented electrical steel sample with dimension of (RD) 4 mm, (TD) 2 mm and (ND) 0.08 mm. Sample scanned using helical phyllotaxis HART. Sample courtesy of Dr. Li Meng, China Iron and Steel Research Institute, China



3D grain map of an AA5657 sample with dimension of (RD) 4 mm, (TD) 2 mm and (ND) 0.5 mm. Sample scanned using helical phyllotaxis HART scheme. Sample courtesy of Dr. Robert Sanders, Novelis, USA

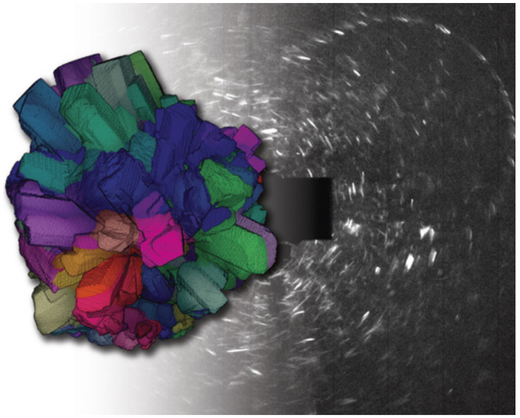


3D grain map of a Sb containing non-oriented electrical steel sample with dimension of (RD) 4.2 mm, (TD) 2.2 mm and (ND) 0.5 mm. Sample scanned using helical phyllotaxis HART scheme. Sample courtesy of Prof. Liuwen Chang, National Sun Yat-sen University, China

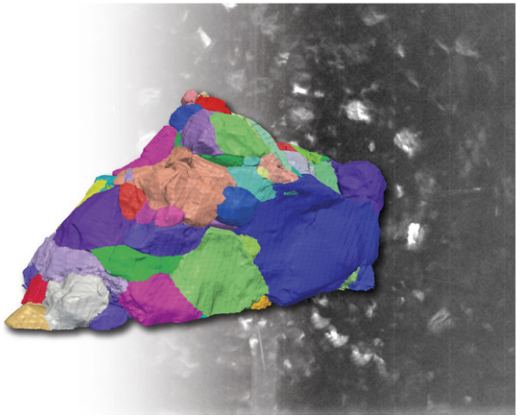


3D grain map of an oriented electrical steel sample with dimension of (RD) 40 mm, (TD) 20 mm and (ND) 0.2 mm. Sample scanned using helical phyllotaxis HART scheme. Sample courtesy of Prof Ping Yang, University of Science and Technology Beijing, China

ZEISS Xradia CrystalCT at Work

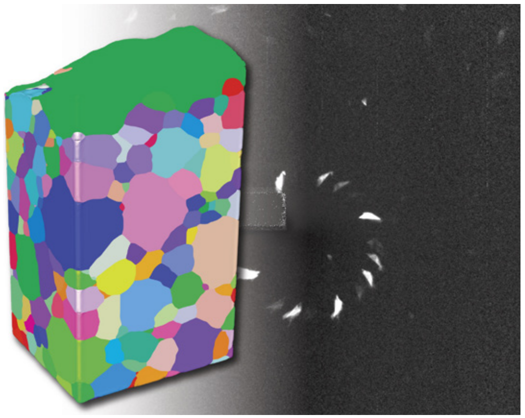


3D grain map of an aragonite sample with dimension of about 15 mm diameter. Sample scanned using helical phyllotaxis scheme.

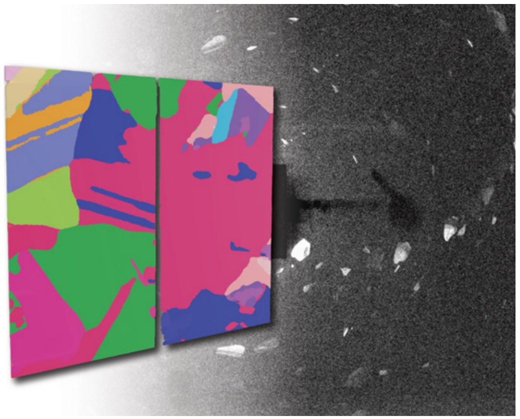


3D grain map of a peridotite sample with height of about 3 mm. Sample scanned using helical phyllotaxis raster scheme.

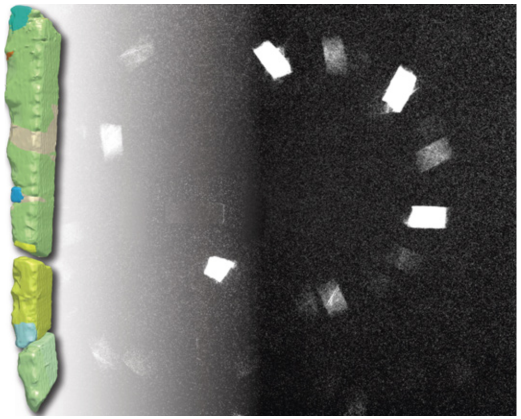
3D grain map of stacked sapphire spheres with individual sphere diameter of 0.2 mm. Sample scanned using helical phyllotaxis scheme.



3D grain map of a SrTiO3 sample with side length of 0.8 mm. Sample scanned using helical phyllotaxis scheme. Sample courtesy of Prof. Amanda Krause, University of Florida, USA

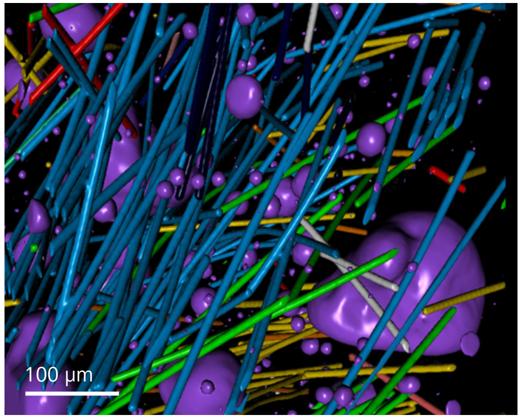


3D grain map of poly silicon materials from a solar panel with height of 30 mm. Sample scanned using helical phyllotaxis HART scheme.

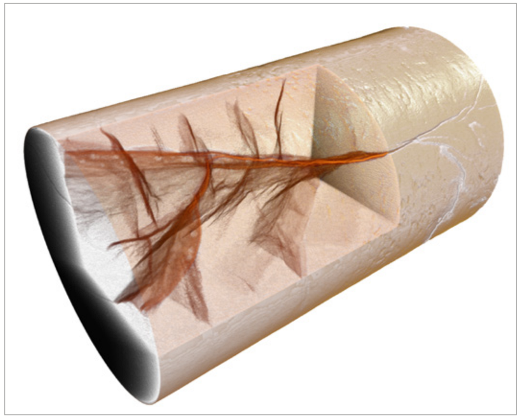


3D grain map of poly-silicon, sample height of 5.3 mm. Sample scanned using helical phyllotaxis scheme. Sample courtesy of Prof. Ashwin Shahani, University of Michigan, USA.

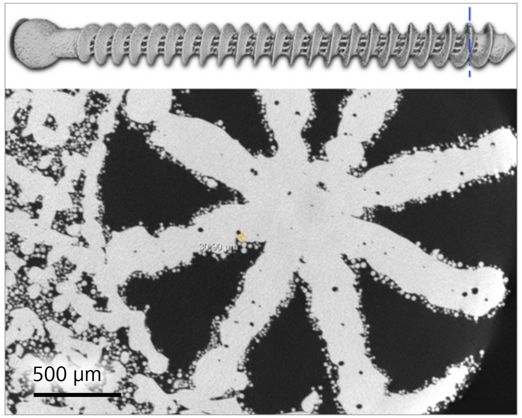
ZEISS Xradia CrystalCT at Work



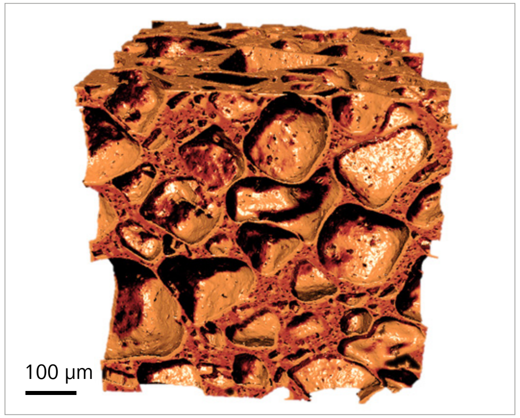
Quantitative volumetric analysis of a steel reinforced concrete specimen. Voids are rendered in purple. The rendering corresponds to a smaller volume imaged out of a large 350 x 100 x 50 mm concrete dogbone test specimen.



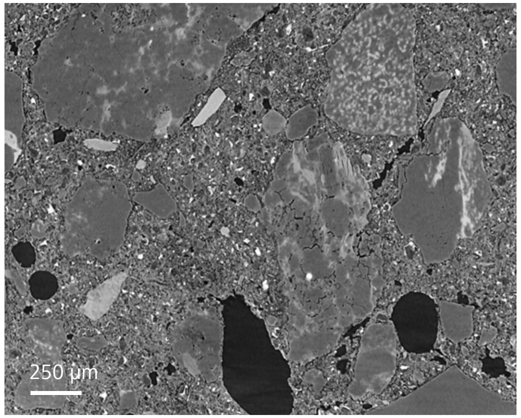
3D rendering of crack networks formed due to corrosion fatigue in the shank section of a load bearing steel bolt.



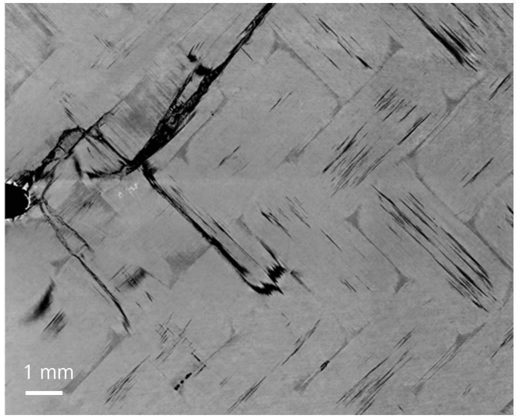
Volumetric rendering of a 3D printed Ti-6Al-4V screw (top). Blue dotted line indicates cross-sectional view from a region of interest scan (bottom), reveals local microstructure and defects such as voids and unsintered powder particles.



Microstructural view of a porous ceramic specimen with a closed pore cellular structure. 3D scans enable quantitative assessment of wall thickness and net porosity.

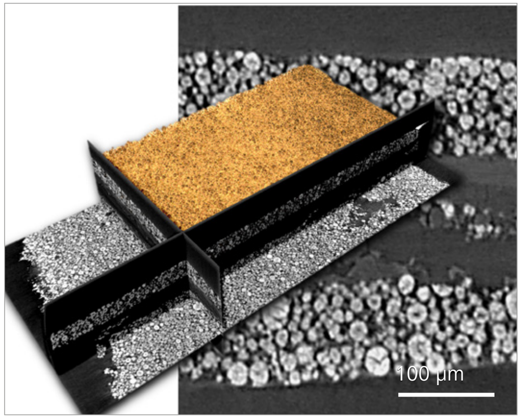


Cross-sectional view of a concrete sample scanned at 0.8 µm/voxel resolution. Various phases of concrete can be observed in distinct contrast. Finer interfacial spacing between the large particles and aggregates can also be discerned.

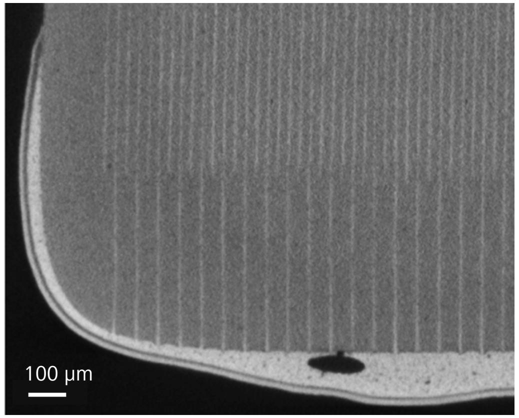


Cross-sectional view of a cascade of cracks initiating at a notch and propagating through a densely packed woven carbon fiber composite panel.

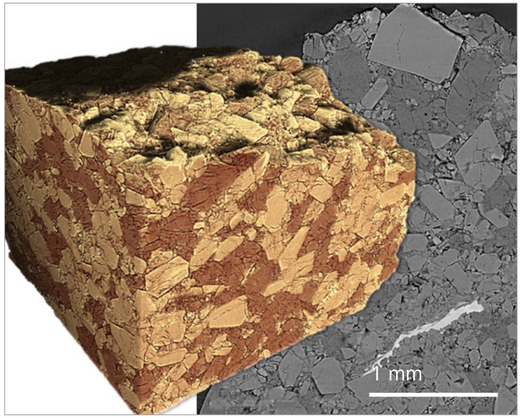
ZEISS Xradia CrystalCT at Work



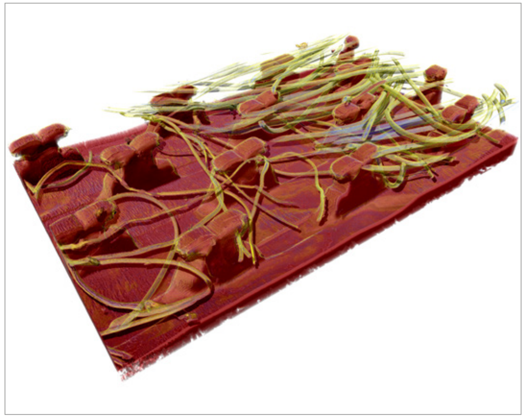
Lithium ion battery cathode. Degradation damage can be characterized by imaging the cathode material from a de-packaged battery after charge cycling.



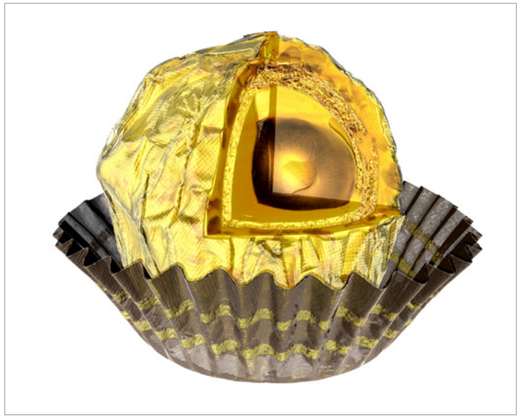
Virtual cross section of a multi-layer ceramic capacitor. 3D imaging reveals the alternating layers of ceramic and thin metal electrodes. Also note the large defect (void) at the electrode contact layer.



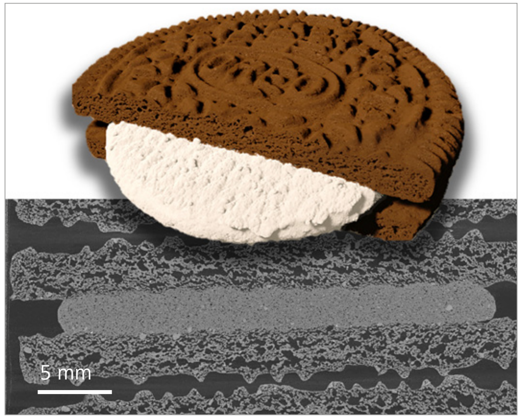
Pharmaceutical ingredient L-Glutamic acid, which has two polymorphs that are imaged. 3D rendering and 2D virtual cross-section show high contrast between the two phases and the interface crack network.



A patch of the microscopic hook and loop secure on disposable diapers imaged using CrystalCT reveals the loop structures of the fibers that engage with the rows of hooks. Both the fiber and hook structures are made of low-density polymers yet can be seen in excellent contrast and clarity.



Full field of view imaging of a fine chocolate confectionery. The chocolate and wafer have been virtually sectioned to reveal the central hazelnut core. CrystalCT delivers superior contrast even for low absorbing samples.



3D rendering and virtual cross-sectional view reveal the interior structure of an Oreo cookie. The cross section reveals the porous microstructure and different phases in the cream and cookie halves.

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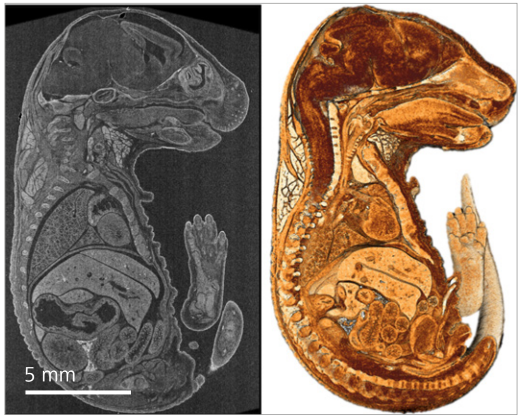
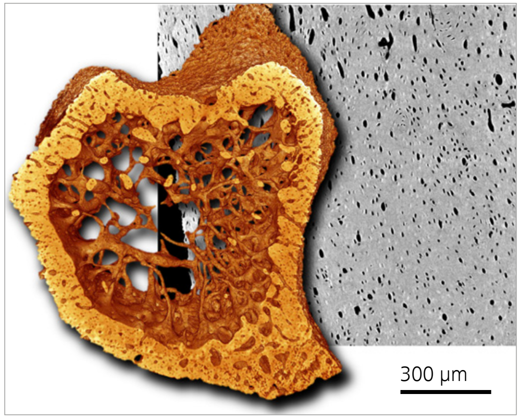


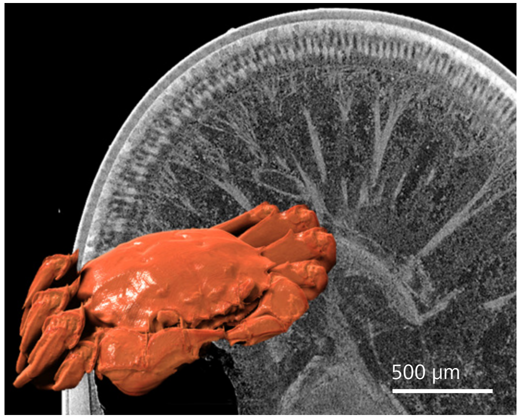
2D virtual cross-section and a cutaway view of 3D rendering of a mouse embryo embedded in paraffin. Internal structures are visible with high contrast. Sample courtesy of Massachusetts General Hospital.



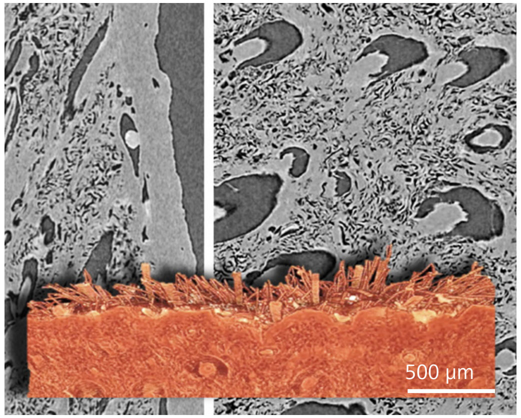
3D rendering and 2D virtual cross-section of a mouse tibia showing the bone microstructure. 3D rendering shows the trabecular network.

3D rendering of a bear jaw. CrystalCT enables efficient large sample scanning.

Microstructural view of a Cyclanthus Bipartitus seed using absorption contrast tomography. 3D microstructural features of the seed are discerned in high contrast. The example highlights the potential for use of CrystalCT as an excellent taphonomy tool due to its ability to deliver high resolution non-destructive virtual sections.



Virtual 2D cross section of the compound eye of a crab. Various microstructural details such as the corneal lens, crystalline cones and retinular cells along with the internal features are observed.



Microstructural details of mouse skin observed in 3D (foreground) and 2D virtual cross-sections (background). Various details of the dermal and epidermal layers can be observed.

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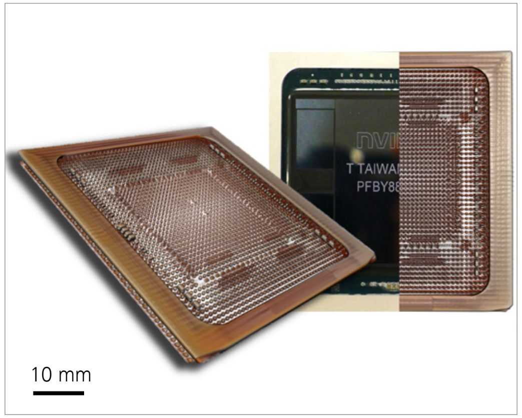
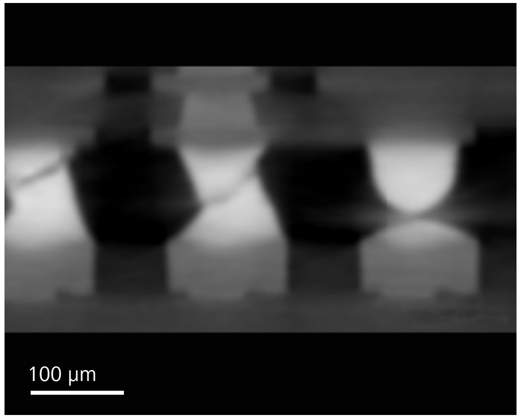
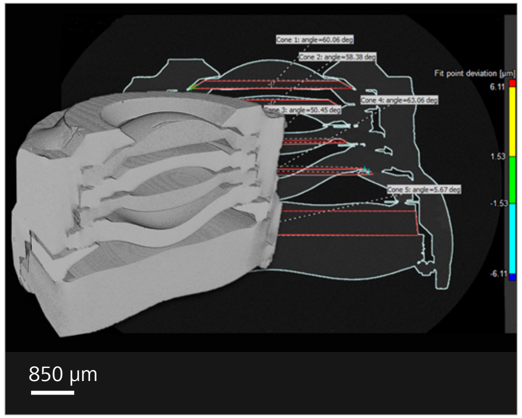


3D color-rendered image of a 2.5D interposer package – Nvidia Tesla v100.

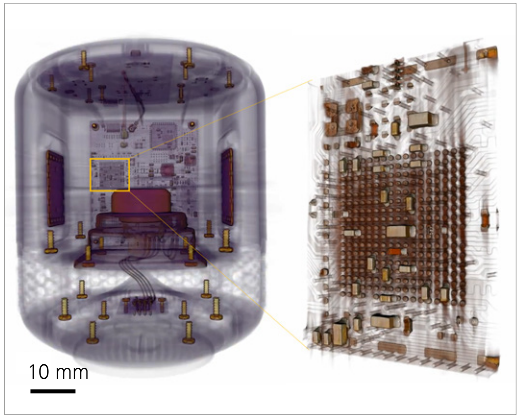


A virtual cross-section image visualizing the non-wet defect on C4 bumps in a semiconductor package.

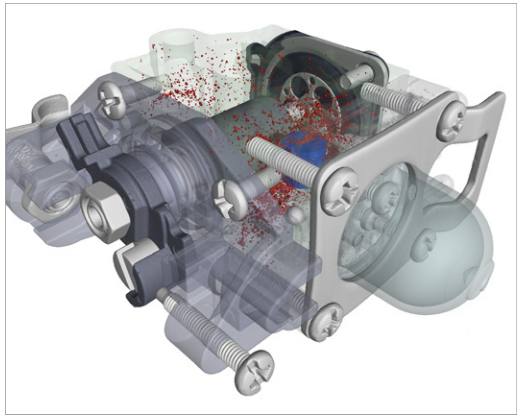


Smartphone camera lens assembly.

3D rendering image of smart watch imaged at 28 µm/vox. Image shows the entire watch assembly as well as the internal features such as motherboard and sound components.

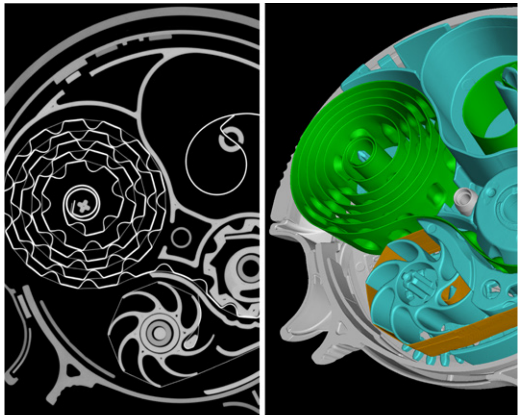


3D rendering images of intact smart speaker scanned at 39 (the left, vertically stitched data) and 7.5 (the right) µm/voxel resolutions. Various interior features of the sample can be observed in distinct contrast.

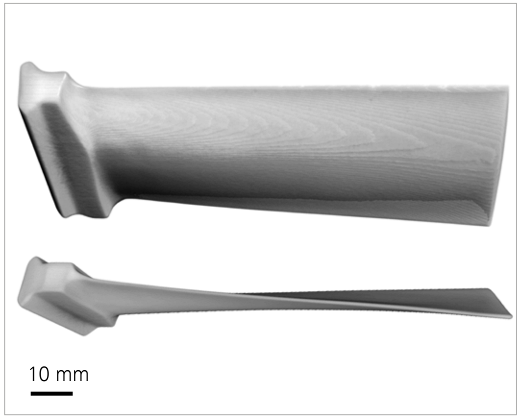


Semi-transparent view of a small carburetor assembly showing its internal components and assessing the porosity of the aluminum casting block.

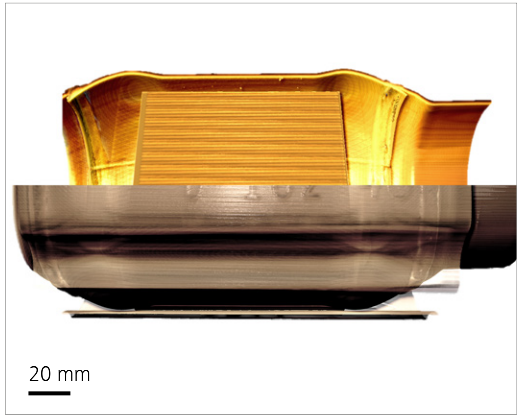
ZEISS Xradia CrystalCT at Work



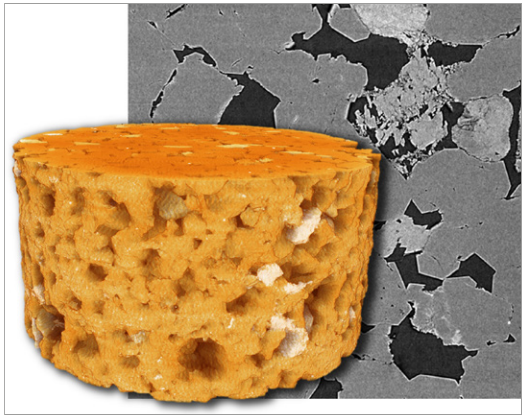
Respiratory drug delivery inhaler device. Left: 2D cross-section and Right: 3D rendering



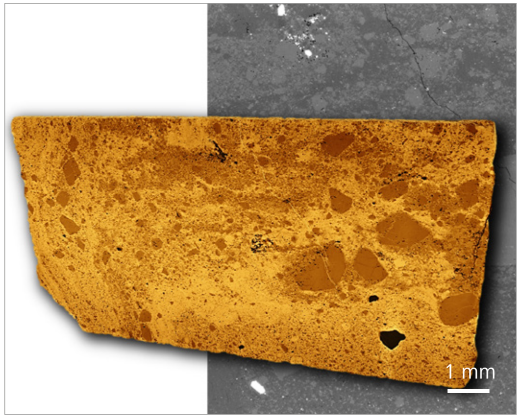
3D rendering of a turbine blade showing the airfoil geometry.



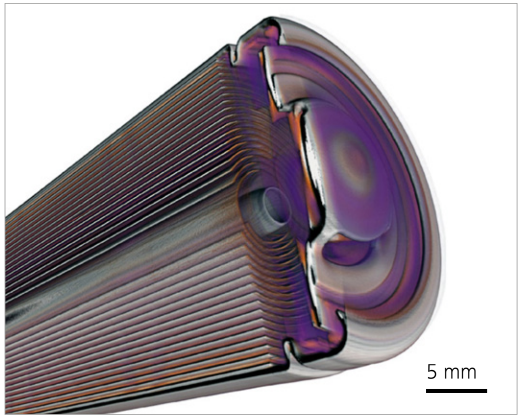
3D scan of an intact catalytic converter. Virtual cross sections allow investigation of the interior structure.



3D rendering of a high permeability Berea sandstone (foreground), 2D cross-section (background). Quartz, feldspar and pores can be clearly distinguished due to the high contrast.



Diogenite sample from Vesta Asteroid. Sample courtesy of NASA.



3D rendering of an intact lithium ion battery.

Your CrystalCT Imaging Solution

1 X-ray microCT
- Large field-of-view, non-destructive 3D X-ray micro-computed tomography system

2 X-ray Source
- High performance, spot-stabilized sealed transmission source (30 - 160 kV, maximum 10 W)

3 Detector System
- High speed, large array CMOS flat panel detector (3072 x 1944 pixels) for large field of view and high throughput

4 Crystallography Acquisition Module
- Set of three DCT source-side apertures
- Set of six DCT zero-order detector-mountable beamstops

5 Crystallography Advanced Acquisition Modes
- For obtaining grain maps in diverse sample geometries
- Helical phyllotaxis
- Helical phyllotaxis-Raster
- Helical phyllotaxis-HART

6 System Stability for Highest Resolution
- Granite base vibrational isolation
- Thermal environment stabilization
- Low noise detector
- Advanced proprietary stabilization mechanisms

7 System Flexibility for Diverse Range of Sample Sizes in Absorption Mode
- Variable scanning geometry
- Tunable voxel sizes
- Vertical stitching for joining multiple tomographies

8 Smartshield for Sample Protection and Setup Optimization
- Fully integrated rapid envelope creation within Scout-and- Scan control system
- Sample and instrument safety in 3D
- Enhanced operator efficiency during experiment setup

9 Advanced Reconstruction Toolbox with Options for Enhanced Performance
- ZEISS DeepRecon Pro with AI-based reconstruction technology for up to 10× throughput or superior image quality on Unique, Semi-repetitive, and Repetitive sample workflows
- ZEISS OptiRecon with iterative reconstruction for up to 4× throughput or enhanced image quality
- ZEISS PhaseEvolve for enhanced contrast and segmentation in low-medium density sample or high resolution imaging applications

10 Autoloader Option *(not pictured)*
- Maximize productivity by reducing user intervention
- Programmable handling of up to 14 samples
- Automated workflows for high volume, repetitive scanning

11 Sample Stage
- 25 kg sample mass capacity

12 X-ray Filters
- Set of 13 filters to tune beam based on sample size and density

13 *In Situ* and 4D Solutions
- Integrated *in situ* recipe control for Deben stages
- *In Situ* Interface Kit option *(not pictured)*
- Custom *in situ* flow interface kit by special order

14 Instrument Workstation
- Powerful workstation with fast reconstruction
- Dual NVIDIA CUDA-based GPU / 128 GB RAM
- Multi-core CPU
- 24” display monitor

15 Crystallography Reconstruction and Visualization Secondary Workstation
- Powerful workstation with fast reconstruction
- Dual NVIDIA CUDA-based GPU/ 128 GB RAM
- Multi-core CPU
- 30” display monitor

16 Software
- Acquisition: ZEISS Scout-and-Scan Control System
- Standard CT Reconstruction: ZEISS XMReconstructor
- DCT Reconstruction: Xnovo Technology GrainMapper3D
- Viewer: XM3DViewer
- Compatible with wide breadth of 3D viewers and analysis software programs
- ZEISS ZEN Intellesis for image segmentation (optional)
- ORS Dragonfly Pro for 3D visualization and analysis (optional)

Technical Specifications

X-ray Absorption Imaging	
Minimum Achievable Voxel [a]	0.5 µm
Spatial Resolution [b]	0.95 µm
Achievable Voxel at Working Distance [a,c]	0.5 µm at 0.5 mm; 0.8 µm at 2.5 mm; 2.5 µm at 12.5 mm; 4.0 µm at 25 mm; 12.1 µm at 100 mm

[a] Voxel is a geometric term that contributes to but does not determine resolution and is provided here only for comparison. ZEISS specifies resolution via spatial resolution, the true overall measurement of instrument resolution.
[b] Spatial resolution measured with ZEISS Xradia 2D resolution target. [c] Working distance defined as clearance around axis of rotation. This value can be interpreted as the radius of the sample.

Crystallographic Grain Imaging (X-ray Diffraction Contrast Tomography)	
Grain Detectability	20 µm
Grain Orientation Angular Resolution	0.1°
Crystal Symmetries	Cubic, Hexagonal, Trigonal, Tetragonal, Orthorhombic, Monoclinic, Triclinic
DCT Advanced Acquisition Modes	Three DCT modes, including Helical Phyllotaxis, Helical Phyllotaxis-Raster, and Helical Phyllotaxis-HART
DCT X-ray Source Apertures	Set of three self-aligning DCT apertures
DCT Detector Beamstops	Set of six zero-order beamstops
DCT Reconstruction and Visualization	GrainMapper3D powered by Xnovo Technology

X-ray Source	
Type	Spot Stabilized, Sealed Transmission
Tube Voltage Range	30 – 160 kV
Maximum Output	10 W

Detector System	
High Speed, Large Array CMOS Flat Panel	3072 × 1944 pixels
Single Field of View (diameter / height)	140 mm / 93 mm
Maximum Field of View (diameter / height)	140 mm / 165 mm

Xradia Platform Stability	
Chassis	Proven stable Xradia Versa platform
Vibration Isolation	Granite base
Temperature Control	Temperature-stabilized interior
Drift Correction Capabilities	Adaptive Motion, Sample Drift, and Thermal tracking and compensation; plus, proprietary advanced methods
Artifact-Free Imaging Methods	Dynamic Ring Removal; Secondary Referencing; plus, proprietary advanced methods

Technical Specifications

Stages	
Sample Stage (load capacity)	25 kg
Sample Stage Travel (x, y, z, θ)	50, 100, 50 mm, 360° motorized micro-positioning capability
Sample Region-of-Interest (ROI)	Intuitive 3D navigation for precise ROI positioning enabled by innovative sample stage architecture
Source Travel (z)	190 mm
Detector Travel (z)	475 mm
Sample Size Limit	300 mm

Features	
Scout-and-Scan Control System	■
Vertical Stitching	■
ZEISS SmartShield	■
XRM Python API	■
CT Reconstruction	Dual, CUDA-based GPU for instrument workstation; Automated parameter selection and unsupervised reconstruction
Crystallographic Reconstruction	Dual, CUDA-based GPU for offline analysis workstation
ZEISS Autoloader*	Optional
In Situ Interface Kit*	Optional
ZEISS OptiRecon	Optional
ZEISS DeepRecon Pro	Optional
ZEISS ZEN Intellesis	Optional
ORS Dragonfly Pro	Optional
ZEISS PhaseEvolve	Optional

* Autoloader and *In Situ* Interface Kit cannot be installed simultaneously on the same system

Product Field Conversion	
Field Conversion to Xradia 620 Versa X-ray Microscope with LabDCT and FPX	Optional

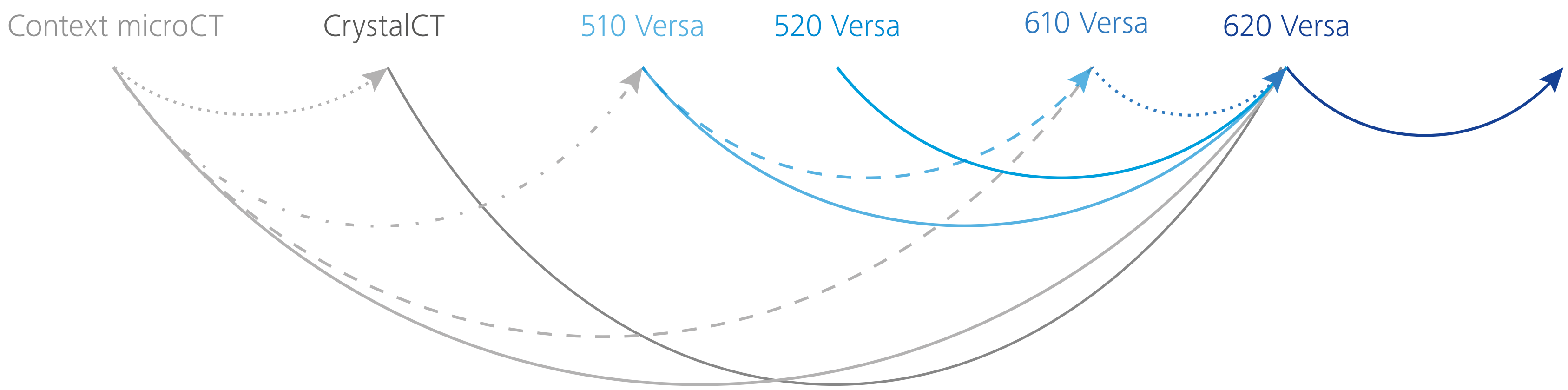
X-ray Safety Standards	
Safety Standards Compliance	UL/CSA 61010-1, SEMI S2-0712, SEMI S8-0712, CE Mark
Radiation Safety	< 1 µSv/hr (equivalent to 0.10 mRem/hr) measured 25 mm above surface of enclosure

ZEISS Customer Focus: Continuous Improvement and Upgradeability

Protect Your Investment extends to Xradia 600-series Versa – delivering unprecedented extendibility and unrelenting support to ensure you are not left behind.

Most ZEISS X-ray microscopes are designed to be upgradeable and extendible with future innovations and developments so that your initial investment is protected. This ensures your microscope capabilities evolve with the advancements in leading technology. This is one of the key differentiators in the 3D X-ray imaging industry.

From Xradia Context microCT and Xradia CrystalCT to Xradia 510/520 and 610/620 Versa, you can field-convert your system to the latest X-ray microscope products. In addition to instrument conversions at your facility, new modules are being continuously developed that will enhance your instrument to provide advanced capabilities such as *in situ* sample environments, unique imaging modalities, and productivity-enhancing modules. Also, periodic major software releases include important new features which are made available to existing instruments, thereby enhancing and extending the capabilities of your research.



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